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ERRATA.

Page 51, line 17, for = 1812, read = 1512.
53, line 29, for 2 *feet* per second, read 2 *revolutions* per second.
—, line 33, for 2898, read .2898.
54, line 2, for 322, read .322.
—, line 17, for 32, read .32.
55, line 8, for *passages*, read *passage*.
57, in the Table, for ° ″, read ° ′.

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Errata in Vol. III.

Page 354, line 9, for "these" read "their."
17, after "copper" insert "box."
26, for "acid" read "oxide."
27, for "acid" read "air."

TO CORRESPONDENTS.

We have received, and are much obliged by the paper on *Elimination*, dated " *Ashfield by Dunbar*," and considering the circumstances under which it has been composed, regard it as a production equally curious and gratifying, Our reason for not having printed it, is, that the author seems scarcely sufficiently aware of the present state of that part of mathematical enquiry: though his views are not without originality.

Mr. Watts " on the pendulum," did not arrive early enough for this Number, so that, with his permission, we reserve it for Number IX.

We have received so much craniological information that we are obliged to waive the discussion altogether, hoping that, like the art of memory and other bubbles, it will die a natural death.

We beg to thank Professor Bigelow for his various communications.

Dr. Hall's paper arrived too late for this Numer; the wood-cut could not be executed in time.

THE QUARTERLY JOURNAL

OF

SCIENCE AND THE ARTS

ART. I. *Of the Dissemination of Plants. From the French of* M. C. F. Brisseau Mirbel.

By dissemination, we mean to express the spontaneous dispersion of the seeds of the vegetable creation; an event, which while it brings to a close the yearly round of the vegetative functions of the individual, becomes the means of giving perpetuity to its race. When completed, the organs of the plant in which existence surpasses one year, tend visibly to a state of inactivity, and in that where this concludes with the year, to decay; being there in fact the first stage of dissolution. When we see the fruit separate from the parent-stem, its seams begin to open, the ligatures of the seed detach themselves from the placenta, we are not to place these appearances to the account of the energy of the vital principle, but on the contrary, to view them as the certain indications of its having ceased in that portion of the vegetable where they occur. Fruit undergoes the destiny of the leaf in autumn, and is quickly reduced within the control of those laws which govern all inorganic matter. If of a succulent pulpy nature, the fluids ferment and turn sour, the texture collapses and the whole is dissolved by putrefaction; if of a ligneous dry consistence it follows precisely the course of the wood or the leaf in which vegetation has ceased.

In animals the affection they bear their offspring, the instinct they are endued with for its protection and succour, their strength, their courage, their address, are all so many

means of ensuring the perpetuity of their races; but to vegetables, sensation and the sources of spontaneous movement have been denied, and yet even here we see countless races appear before us on each revolving year, such as they appeared in the first days of their formation. Let us turn our attention to the causes of this wonderful stability in the races of vegetables.

The most efficient is without doubt the prodigious fecundity they are endowed with. Sir Kenelm Digby tells us, that the fathers of the congregation of La Doctrine Chrétienne at Paris, had in their possession about the year 1660, a single barley-plant with 45 straws producing in the aggregate 18,000 corns of barley. Ray counted 32,000 seeds in the heads of one plant of poppy, and 360,000 on one tobacco-plant. Dodart recounts of an elm, that it produced 529,000 seeds. Yet none of these vegetables are among those of the foremost ranks in the degrees of fecundity. The number of seeds borne by a plant of Begonia, or Vanilla, but above all by a fern, confounds calculation.

Although many kinds, like those of angelica, fraxinella, and coffee, quickly spoil, and require to be sown almost as soon as ripe; yet the far greater proportion preserve the germinating faculty for years and even for ages. We have ourselves recently witnessed the growth of the seeds of a kind of kidney-bean which had been taken from the Herbarium of Tourneforte. Home sowed with success barley that had been gathered 140 years. Wheat has been discovered in subterraneous hoards, which had been lost and forgotten for time out of mind, in as perfect a state as the day it was reaped.

Insects, birds, and four-footed animals are the great destroyers of seeds; yet their abundance is such as prevails over the voracity of their consumers; while some are defended from all risk by the hardness of their coverings, or the thorns which arm them, or the acrid and corrosive juices with which they are impregnated.

Spontaneous dissemination favourable to the developement of individual plants by preventing the too great accumula-

tion of seed within a too narrow compass, is carried on in various ways. In the balsam, catchfly, fraxinella, sand-box-tree, &c. the valves of the seed-vessel open with a spring that projects the contents to a distance from the parent-plant. The gourd of the spirting cucumber, by a contraction which takes place at the moment of its fall, darts out the seed along with a corrosive fluid by a vent formed as it quits the stalk. The seed of the wood-sorrel is contained in an extensile arillus or separate pouch, which dilates as the seed-vessel grows, but at last the power of extension ceases in the pouch, when it bursts and shoots out the seeds by an elastic effort. Plants of a lower degree in the scale of organization, such as the mushrooms, have their peculiar means of disseminating the particles destined for their reproduction. For instance, some of the species of Peziza impart a vibratory motion to the cap or cover which bears their seed when that is ripe. Puff-balls, also of the mushroom-tribe, burst at the top like the crater of a volcano, and the seed is in such quantity and so fine that when it escapes it has the appearance of a volume of smoke. The capsules of ferns likewise open with a spring, an effect of their contraction in drying up when ripe. A like cause gives motion to the cilia or inner fringe which surrounds the urns or seed-vessels of mosses. But although such partial phenomena, may attract our curiosity, they act only a very subordinate part in the grand total of dissemination. There are other more general and powerful causes to be mentioned in this place.

Many seeds are as fine and volatile as the dust of the anther; the winds carry these away to scatter them on the plain, the mountain, the building, and in the very depth of the cavern. No place seems closed against the intrusion of the impalpable seeds of the various sorts of Moulds (*Mucores*).

Heavier seeds and fruits are furnished with wings, which support them in the air, and serve to waft them through great distances. The seed-vessel of the elm is surrounded by a circular membranous wing; that of the ash is terminated by one that is oblong. The keys or seed-vessel of the maple has two large side-wings. The seeds of the fir, the cedar,

and the larch are furnished with a wing of great fineness. The peduncle of the capsule of the lime-tree adheres to a kind of broad bracte which plays the part of wings.

The seeds of syngenesious plants are furnished with a feathery crown or aigrette, and look like small shuttle-cocks. The separate threads that compose this aigrette distending as they dry, serve as levers to lift the seed from the involucre that holds it, and when out, as a parachute to prevent its coming to the ground, and to buoy it in the air.

Linnæus suspects that the ERIGERON *canadense* came through the air from America to Europe, not at all an impossible thing. When once that syngenesious plant has found its way into any quarter, it is sure to disperse and sow itself round the whole neighbourhood.

The funiculus (a cord which attaches the seed to its receptacle) of the dogsbane, swallowwort, periploca, &c. the calyx of several of the valerians and scabiouses form of themselves elegant aigrettes resembling those of the seed of the syngenesious plants.

Seeds are often carried by eddies of winds far from the spot on which they grew. Whirlwinds have been known to scatter over the southern coast of Spain those that had ripened on the northern coast of Africa.

Some fruits are closed hermetically and so constructed as to swim on the water. These are carried to every distance by torrents and rivers, as well as the sea itself. Cocoa-nuts, cashew nuts, and the pods of the MIMOSA *scandens* sometimes of the length of two yards, with many other fruits of the tropical regions, are cast upon the shores of Norway, in a state to vegetate, did the climate permit.

Regular currents transport the large double cocoa-nut of the Sechelles, to the coast of Malabar at the distance of 400 leagues from whence it was produced. Fruits brought by the sea have sometimes discovered to uncivilized nations the existence of those islands which lay to the windward of their country. By such tokens Columbus in the search of the American continent was apprised that he was not far distant from the land of which he had prognosticated the existence.

Linnæus remarks that animals co-operate with great effect in the dissemination of seed.

The squirrel and cross-bill, are both very fond of the seed of the fir; to open the scales of the cones they strike them against stones, and thus set free and disperse the seed.

Crows, rats, marmots, dormice convey away seeds to stock their hoards in out-of-the-way places. These form their winter-stores, but are often lost or forgotten, while their contents come up in the spring.

Birds swallow the berries, of which they digest only the pulp, but void the stones entire and ready to germinate. It is thus that the thrush and other birds deposit the seed of misletoe on the trees where it is found; and indeed destitute as this is of wings or aigrettes, it could not be disseminated in any other way, for it will not grow on the ground.

The Poke of Virginia (Phytolacca *decandra*), which was introduced by the monks of Corbonnieux into the neighbourhood of Bordeaux, for the sake of colouring the wine, has been since disseminated by the birds throughout the southern departments of France, and in the deepest vallies of the Pyrenees.

The Dutch, with the view of monopolizing the trade of nutmegs, extirpated the trees on those islands which they could not watch so narrowly as the rest; but in a short time these very islands were re-stocked with nutmeg-trees by the birds; as if nature refused to admit of such encroachment on her rights.

Granivorous quadrupeds disseminate the seed they do not digest It is known to every one that horses infect the meadows with new weeds.

The fruit of the prickly-seeded scorpion-grass, of cleavers or goose-grass, of the wood-sanicle are all provided with small hooks by which they lay hold of the fleeces of the flock, and accompany its migrations.

There are particular plants, such as the pellitory-of-the-wall, the nettle, and the sorrell, that may be said to seek the society of man, and actually to haunt his footsteps. They spring up along the wall of the village, and even in the streets

of the city, they follow the shepherd, and climb the loftiest mountain with him. When young I accompanied M. Ramond in his excursions in the Pyrenees, where that learned naturalist more than once pointed out to me these deserters from the plains below; they grew on the remains of ruined hovels, where they kept their station in defiance of the severity of the winters, and remained as memorials to attest the former presence of man and his flocks.

Distances, chains of mountains, rivers, the sea itself are but unavailing barriers to the migration of seed. Climate alone can set bounds to the dispersion of the vegetable races; that only draws the line which these cannot transgress. In process of time, it is probable that most of the plants which grow within the same parallel of latitude will be common to all the countries comprized in the entire zone of it; an event which would be one of the great blessings resulting from the industry and persevering intercourse of civilized nations. But no human power will ever force the vegetable of the Tropics to endure the climate of the Poles, nor *vice versâ.* Here nature is too strong for man.

Species cannot spontaneously spread themselves from one pole to the other, the intermediate differences of temperature preventing such progress; but we may assist in transporting them, as we have done successfully in various instances. We have already transplanted the eucalypti, the metrosidera, the mimosas, the casuarinæ and other plants of Terra Australis into our own soil; while the gardens of Botany-bay are stocked with the fruit-trees of Europe.

The dissemination of seed completes the round of vegetation. The shrub and the tree are bared of their foliage; the herb is dried up and returns to the earth from which it came. That earth appears to us as if stripped for ever of her gay attire, yet countless germs wait but the stated season to re-adorn her with verdure and bloom. Such is the prodigal fertility of nature, that a surface of a thousand times the extent of that of our whole globe, would not suffice for the seed harvest of a single year, provided the whole was suffered to reappear; but the destruction of seed is endless, and only

a small portion escapes to rise again. In no way in our view are the power of nature and the immutability of its laws more strikingly displayed, than in the successive resurrections of the types of by-gone generations.

Of the Death of Plants, from the French of the preceding Author.

Plants, like animals, unless destroyed by disease or casualties, are doomed to die of old age.

In many of the *mucores* (plants which constitute mouldiness) *byssi*, and mushrooms, the verge of life does not extend beyond a few days, or even hours.

The herbaceous plants we call annuals, die of old age considerably within the term of a year. In our climates their death takes place on the approach of winter. But we are not on that account to conclude that cold is the primary cause of the event; a milder climate would not have protracted their existence. Plants of this nature which grow under the line itself are scarcely longer lived than those which grow in the regions bordering on the poles. In both situations they perish when the propagation of the species has been secured by the ripening of the seed.

In the herbaceous plants we call biennials, only leaves make their appearance in the first year. These generally die away when winter comes; in the spring a new foliage, the forerunner of the flower-stem, is evolved. The blossom soon appears, this is followed by seed, after which the biennial dies in the same way as the annual.

In the herbaceous plants called perennials, the parts exposed to the action of the light and air perish every year after they have seeded; but the root survives in the ground, new stems are thrown up in the following spring, and blossom and seed is again produced.

In the generality of woody plants, death does not supervene until the process of fructification has been repeated for a greater or less number of years. There are trees however belonging to the monocotyledonous class, as the sago-tree (*sagus*

farinifera), the umbrella-tree (*corypha umbraculifera*) with immense fan-formed leaves of 8 or 10 yards in length, which only bear fruit once, and then die; but on the other hand, in the dicotyledonous class there are enormous trees, whose existence seems to date from before the records of history, and which, in spite of their antiquity, are loaded in each returning year with blossom and seed.

If we were to view the perennial and the woody plants as simple individuals, as such we should be naturally induced to conclude, that unless destroyed by disease or casualties they were free from the liability to death from old age; but a due consideration leads us to distinguish in every perennial and woody plant the new part which actually lives and grows, from the old which has ceased to grow and is dead.

I will state this in a broader way. Plants of this nature have two modes of propagating their races; one by seeds the other by a continuous evolution of like parts.

In the first case, the seed presents us with an embryo-plant, a new and different individual, independent and unconnected with that from which it derived its existence; in the second case we are presented with a series of individuals, which issue from the surface the one of the other in an uninterrupted sequence, and in some instances continue permanently united. But whether individuals of this description are produced by seed or continuous evolution, it is certain that they escape, in neither case, the influence of time. While the succession of individuals or what we may call the race, produced in either of the ways, is on the other hand as clearly beyond the reach of age and will endure until destroyed by some extraneous cause.

We will endeavour to show how these general laws apply.

All the parts of the young herbaceous annual are susceptible of enlargement; the cells of the tubes, at first very small, are soon after extended in every way; in process of time their membranous walls, fortified by the absorption of nutritious juices, grow thicker, and lose by degrees their original pliancy. The membranes once hardened, excitement ceases to be produced, and the vital functions are at an end; nou-

rishment is no longer drawn, growth is at a stand, and the plant unable to resist the ceaseless attacks of the external agents employed by nature for its destruction, decays in a short time.

Similar causes induce similar results in the stems of the herbaceous perennials; but there the root is regenerated by a succession of continuous evolutions.

By renewals of the same nature the life of shrubs and trees proceeds. In them the liber or inner bark represents the herbaceous plant, and has like that only a short period of vegetative existence. For when vegetation revives in the woody plant on the return of spring, it is because a new liber endowed with all the properties of a young herbaceous plant, has replaced under the cortex or rind the liber of the preceding year, which has hardened and become wood.

The yews of Surrey, which are supposed to have stood from the time of Julius Cæsar, and are now 2 yards in diameter; the Cedars on Mount Lebanon, 9 yards in girth, from the measurement of the learned Labillardiére; the fig-tree of Malabar, according to Rumphius, usually from 16 to 17 yards round; the stupendous chestnuts on Mount Ætna, one of which, Howell tells us, measured 17 yards in circumference; the Ceibas of the eastern coast of Africa, of such bulk and height that a single stick is capable of being transformed into a pirogua or sailing vessel of 18 or 20 yards from stem to stern and of 3 or 4 in the waist; the baobab of Senegal of 10 or 12 yards in girth, and, according to the computation of Adanson, 5 or 6000 years old; all of these, giants as they are, vegetate, as does the smallest bush, solely by the thin herbaceous layer of the liber annually produced at the inner surface of their bark. The concentric layers of preceding libers constitute the mass of the wood, a lifeless skeleton, serving solely to support the new formed parts, and to conduct to them the juices by which they are fed; nor is it even necessary for these functions that this should be in an entire state. Willows and chestnuts when quite hollow at the heart, still continue to grow with vigour; but in their soundest state, strip them of their bark, and they quickly perish.

Thus reflection teaches us that the long life of the greater part of trees, and the immortality which at first sight appears to have been imparted to others as well as to the whole of the herbaceous perennial plants, form in reality no exception to the general law which destines every organized individual to perish in determined course; since we see that the old parts of the roots of the herbaceous perennial continue constantly to die away under ground, and are succeeded by new ones, and that the concentric layers which constitute the wood or heart of the trunks of trees, are no other than the accumulated remains of by-gone generations, in which vegetation and life are entirely extinct.

This appears to us the true view of the nature of the life and death of such beings as are constantly regenerated by the successive evolutions of like continuous parts.

And we may observe that the liber which is formed on the stem of a tree of centuries old, if the tree has met with no accidental injury to affect its health, enjoys the vegetative power in as full force as the liber which is formed on that of the sapling; and that a sound well grown scion from the aged but healthy tree, affords as good a cutting for propagation as that taken from the young one, so that the race might be perpetuated by cuttings alone, without the assistance of seeds. From this we are entitled to conclude, that according to the course of nature, the progress of regeneration by continuous evolution would never be arrested, if the overgrown size of the branches and stem, the hardening of the wood, and the obstructions of the channels which permeate it, did not impede the circulation of the sap, and consequently its access to the liber.

In fine, what we call death by old age in a tree, to speak correctly, is the extinction of that portion of a race which has been carried on by continuous evolution; the inevitable result of an incidental death in the liber occasioned by the privation of nourishment.

The life of trees has been commonly divided into three stages; infancy, maturity, and old age. In the first the tree increases in strength from one day to the other; in the

second it maintains itself without sensible gain or loss; in the third it declines. These stages vary in every species, according to soil, climate, aspect, and the nature of the individual plant. The common oak usually lasts from 6 to 900 years, and the stages of its existence are of about 2 or 300 years each. It has been observed to live longer in a dry than in a wet soil. The same may be said of the chestnut.

Every species, in order that it may attain its due growth, requires a certain temperature to be found within limits of a greater or less extent.

The common oak, the fir, the birch, &c. thrive most towards the north; the ash, the olive tree, &c. in the warmest parts of Europe; the baobab, the ceiba, and the palm, flourish and become robust no where but between the tropics.

According to Sir Humphry Davy, the respective quantities of carbon furnished by different woods afford a tolerably exact scale wherewith to measure their longevities. Those in which carbonic and earthy substances abound, are the most lasting; and those in which the largest proportion of gaseous elements is found, are the least so. This rule may hold good in regard to our indigenous trees; but I doubt whether the baobab, the ceiba, and many other tropical trees, the wood of which is of a loose and soft texture, will afford from masses of equal size, the same proportion of carbon as our oaks, chestnuts, or elms, although they grow to a much greater age.

Sir Humphry Davy is also of an opinion that trees of the same species grow to a more advanced period in the north than in the south, as cold guards against fermentation and dissolution of parts; but every tree lives the longest when it is in that climate which is the best adapted to its nature. Sir Humphry's opinion would be unquestionable if the vegetable species in view were organized so as to be adapted to grow in all the climates of the globe, and it was then found that their duration was constantly greater towards the Poles than towards the Line. I do not doubt that more oaks of a great age, and more firs also, are found in the north than in the south of Europe; but it is on the other hand beyond a doubt that the Ashes of Calabria and Sicily are longer lived than those of

Prussia and Great Britain. These are phenomena which depend upon the particular nature of species, and of this subject we know nothing.

In proportion as a tree encreases in size the vessels of its ligneous layers become obstructed, and the sap circulates with less freedom; hence absorption and secretion decrease after youth, in proportion as the bulk of the tree is enlarged. The liber is less vigorous; the buds and roots become fewer and feebler; the branches wither; the stem decays at the head; water settles in the injured parts; the wood moulders away. Ere long, the new liber, the annual herbaceous part of woody vegetables, loses the power of completing its regeneration, new parts are no longer evolved, and the tree perishes.

The tree after death is overrun by *pucciniæ, mucores, sphæriæ*, and other cryptogamous plants; it attracts and imbibes moisture, no longer as formerly by the absorbing power of its organs, but by the hygrometrical property it derives from its porous conformation, and the chemical action of the elements which compose it; the oxygen of the atmosphere consumes a part of its substance; some water is generated, carbonic acid gas is disengaged; and the rest is resolved into vegetable mould (*humus*), a fat brown powdery substance, eminently fertile, in which we find in different proportions the same elements as those of which vegetables are composed, and which have the faculty of decomposing air and combining with its oxygen.

It is thus the career of plants is terminated in the order of things. The earth they adorned in the period of vegetation, is fertilized by their remains; germs impregnated with new life have already been confided to its bosom, ready to supply the by-gone generations, and through the death of individuals an unfading youth is secured to the race.

ART. II. *An Inquiry into the Influence of Corporeal Impressions in producing Change of Function in the living Body. By* J. R. PARK, *M. B. F. L. S. and M. R. I.*

THE principles already ascertained, are sufficient to account for the origin of those diurnal fluctuations, experienced alike by the powers of the body and the faculties of the mind.

The due performance of every function has been shewn to depend upon the state of circulation in the capillary vessels of each organ; and these vessels, constituting a peculiar modification of the moving power, were found subject to the general laws of motion: consequently, every organ exhibits, in some degree, those changes which mark the successive stages of action, and each, at stated periods, requires and obtains a suspension, or at least a remission of its efforts.

But the diurnal, are not the only changes to which the animal frame is subject; for every impression acting strongly either on the body or the mind, causes some change of circulation; thus, fear drives the blood from the face, shame augments its afflux to that part, and every cause of local irritation, such as scratching or rubbing the surface, occasions a more abundant flow of blood to the part affected.

Nor are these effects always confined to the seat of the irritation, but often extend to other parts remote from and apparently unconnected with it. Thus, taking any thing hot or spicy into the stomach produces an instantaneous glow in the face. These, and many similar phenomena observed by physiologists, are vaguely termed sympathetic, the nature and cause of which are among the most intricate and important problems in physiological science.

The first writer who offered a satisfactory explanation of the performance of those functions, which are carried on without the interference of the will, such as circulation, respiration, and others, was Dr. Whytt. His views were equally remote from the limited notions of the mechanical physicians, who regarded the animal frame as a mere machine, and from the

fanciful theory of the followers of Stahl, who assigned to each function a presiding spirit to regulate its performance, and to guard against its disturbance.

Dr. Whytt shewed, as formerly stated, that involuntary organs owe their exertion to the immediate influence of the sentient principle, rendering them susceptible of impression, and causing them to act, without the intervention of the will, in correspondence to these impressions.

Satisfied however with having thus affixed a more definite meaning to the term stimulus, he did not proceed to examine the precise nature of the feelings, habitually experienced by these organs, but ascribed to each a peculiar susceptibility of irritation from the fluid in contact with it.

Bichât, whose views nearly coincided with those of Whytt, admitted, as formerly noticed, the occurrence of this mode of sensation, unaccompanied with conscious reflection, but adopting the same error with regard to the nature of these inconscious feelings, equally assumed that a relation obtained between each organ and the fluids habitually in contact with it, rendering the organ in a particular manner sensible to the impression of this fluid.

The fallacy of this assumption has already been fully proved, when it was shewn that the fluid, habitually in contact with each organ, is almost the only one that does not excite irritation; every other, whose impression is novel or strange, producing that effect, and causing thereby a change of action; while its own peculiar fluid, deprived of all irritating qualities by the process of assimilation, and rendered familiar by habit and constant application, acts only by its mechanical impulse, or the distension of fibres it occasions.

When however, any change in the state of these fluids takes place, in consequence of which the habitual impression is altered, then irritation arises, and a change of action ensues. This power of exciting change of action constitutes in fact the principal difference between the articles employed for medicinal purposes, and those that serve to nourish the body. The latter readily assimilating with the natural fluids, soon cease to excite irritation; while the former, incapable of assimilation,

cause that continued resistance which leads to their expulsion from the body.

Irritation also arises in the first instance from the materials, of nutrition, that is, before they are assimilated, and is even requisite in some degree to promote digestion, by augmenting the secretion of those fluids which perform the process of assimilation; and hence, the use of salt, spices, and other condiments. When the powers of assimilation are enfeebled, or the vessels more susceptible than usual, this irritation is often prolonged in duration and increased in degree. Hence arises the chilliness felt a short time after eating in persons of weak digestion or irritable habit of body, when the chyle, imperfectly assimilated, mixes with the circulating fluids, and excites a general shrinking or contraction in the capillary vessels.

The effects resulting from change of impression thus appear to belong to the most important phenomena of life; and although the powers of medicine are not to be exclusively ascribed to irritation, yet the influence of sensible impressions is in some degree necessary to be considered in explaining the operation of almost every remedy, as well as the origin of every derangement of function that occurs.

The causes that act upon the animal frame are either bodily or mental; and each, when sufficiently powerful, is capable of producing change of function.

To corporeal feelings belong all those arising from physical causes, which being applied to the body, produce change of action in the part affected, whether their impression be sufficient to excite attention in the mind, or otherwise.

To mental feelings belong those emotions of the mind, commonly termed passions, excited by external causes, and not dependant upon the will; being perfectly distinct from intellectual operations, which are for the most part voluntary, and unattended with emotion.

The influence of the passions on the bodily frame will be reserved for future inquiry; that of coporeal feelings requires to be first considered.

Painful Impressions.

Corporeal impressions may be either painful or grateful to the part that experiences them, and different effects, as might be expected, are found to result from each. Though it may appear preposterous to apply this distinction to impressions that excite no consciousness in the mind, as is the case with organic feelings, yet, since we are constrained to admit the existence of such feelings, there seems no reason to doubt that they are analogous in their nature and operation to those which are attended with consciousness, as will be seen from the examples adduced.

The effects that result from corporeal impressions are varied by diversity of structure and function in the part that receives them. When the feeling excited is such as to waken consciousness in the mind, the will may assist in determining the means of obtaining relief; but the actions of involuntary organs, resulting from feelings unattended with reflex consciousness, and independant of the will, are governed by fixed and determinate laws. These organs are constructed in such a manner, and endowed with such properties, that their own spontaneous effort is commonly sufficient to procure the removal of a noxious impression; and this constitutes the only real "*vis medicatrix naturæ.*"

Although the mind has often a limited influence, and sometimes assists their efforts by the co-operation of parts subject to her control, as the diaphragm and abdominal muscles are made to assist in the efforts of coughing, vomiting, and the expulsion of urine and fæces; yet by a careful examination of the phenomena, when divested of this combined agency, the influence of corporeal impressions on the animal economy may be reduced to a few general principles.

The usual and primary effect of a painful impression, is resistance in the part that experiences it; but as the powers of resistance are limited, the increased effort of contraction excited is commonly followed by a proportionate relaxation after a certain period.

The increased contraction that results from the application of an irritating cause, is more especially observable when that cause is internally applied; when external, as will hereafter be shewn, a contrary effect appears to result.

The following instances serve to exemplify the increased efforts of contraction proceeding from internal irritation.

In the stomach, eructations, nausea, or vomiting are the usual consequences of displeasing impressions applied to the internal surface of that organ. These consist in increased efforts of contraction in the fibres surrounding the organ, assisted moreover in the act of vomiting by the co-operation of the diaphragm and abdominal muscles, which compress the stomach between them, and cause its contents to be ejected. In the intestines, internal irritation is productive of diarrhæa, chiefly dependant upon increased efforts of contraction in the fibres surrounding this canal, accompanied also by increased secretion, produced in a manner to be hereafter explained. In the bladder, internal irritation excites frequent micturition, effected by the gradual contraction of that organ, assisted also by the co-operation of other parts more subject to the will. In the ureters and in the gall-ducts, the irritation of a calculus or of a gall-stone distending them, occasions a spasmodic contraction above and below the irritating cause, which becomes thereby fixed, and for a time obstructs the passage. In the sphincters, inordinate distension, the only mode of internal irritation to which they are exposed, produces, as before shewn, spasmodic resistance; hence the obstinate constipation arising from immoderate accumulation of fæces, and the strangury produced by long retention of urine and over distension of the bladder. In the vascular system, similar effects arise from internal irritation, hence, the chilliness from contraction of the capillary vessels, after eating, already noticed, as occuring in persons of irritable habit, or feeble powers of digestion, when the chyle, imperfectly assimilated, mixes with the circulating fluids. To the same principle are to be referred the rigor and chilliness that constitute the cold fit of fever, in those species which proceed from an irritating cause. And the action of certain medicines, which promote

transpiration, is also referable to their internal impression stimulating the capillary vessels to increased contraction, and thereby restoring secretion and removing morbid distension. The pores and excretory mouths are analogous in their nature, to sphincters, as formerly shewn, and like them, contract from internal irritation; hence arises their spasmodic resistance, suppressing excretion and transpiration, when the fluids within press too forcibly upon them during inflammation and fever.

Such are the primary effects of displeasing impressions internally applied. The secondary, or the relaxation consequent to increased contraction resulting from the limitation of the resisting power, having been formerly illustrated, need not be repeated.

When the painful impression is applied externally to the organ, the primary effect, as before stated, appears to be different, or relaxation seems to be the result; the reason of which may be enquired into after the fact has been established, as it appears to be by the following examples.

Continued vomiting is often alleviated by the external irritation of blisters applied to the stomach. Cholic or spasmodic contractions of the intestines, are frequently allayed by similar means applied externally to the abdomen. Spasmodic affections of the womb are in like manner alleviated by frictions, fomentations, and other external applications. Spasmodic asthma is often relieved by sinapisms or other strong stimulants applied to the chest or between the shoulders. Chronic cough is often much benefited by a pitch plaister placed upon the breast. In many cases, cupping and leaches appear to afford relief more by the external irritation they occasion than by the quantity of blood withdrawn; and in some cases, dry cupping is employed with advantage. The effects of external irritation on the vascular system are obvious and visible. In whatever way it is applied, whether mechanically, as by scratching or rubbing the surface; or physically, as by the action of rubefacients and blisters, the consequence is an increased relaxation and fulness of the capillary vessels, producing determination of blood to the part. When these vessels are

morbidly constricted, as in the cold fit of an intermittent their relaxation is promptly effected by strong stimulants taken into the stomach. Their impression acting now on the internal, as rubefacients do on the external surface, they tend to relax the constricted vessels, and thus restore circulation. The mouths of the secreting vessels, and the terminations of the excretory ducts opening on the internal surface as well as the pores on the external, appear equally subject to this law. Hence, the flow of saliva is increased by stimulants taken into the mouth. Hence arise the augmented flow of the assimilating fluids from condiments added to our food, the copious secretion of lymph from nauseating substances received into the stomach, and the effusion of serum under the cuticle from the continued irritation of a blister applied to the skin.

Thus relaxation appears to be the immediate effect of irritation external to an organ, as contraction is of that which is internal; and the reason may now be sought for, why opposite effects result from causes apparently similar.

Here two considerations present themselves; one, regarding the nature of this relaxation; and the other, that of the cause which produces it. As to the first, it is necessary to remark that no organ is known to possess a positive power of relaxing or spontaneously distending itself; this change, then, when produced, can only be regarded as a consequence of the organ suspending its usual efforts of contraction, and thereby suffering itself to be distended by the force of the fluids within. Thus, when the vessels of the surface become swollen and distended by scratching or rubbing the skin, their fullness is not to be referred to a positive effort to relax and distend themselves, but to the suspension of their habitual resistance to the fluids within, in consequence of which they suffer themselves to be more than usually distended; or they are passive, and not active in the production of the change in question.

The next consideration regards the nature of the cause that produces this suspension of their usual efforts. The irritating cause, though external to the organ which undergoes a diminution of action in consequence of its application, cannot in any of the instances alleged be regarded as actually applied to the organ itself. Thus, a blister on the chest in allaying

vomiting, or applied to the abdomen in affections of the womb or intestines, cannot be considered, as applied immediately to these organs themselves, but merely to the parts most contiguous to them. In like manner, the redness produced by a rubefacient on the surface, cannot be said to result from an impression directly applied to the vessels, but to the skin immediately over them.

Keeping then these two points in view, the question to be answered will stand thus. Why is the action of an organ diminished or suspended by an irritating cause applied to a part contiguous.?

It is an aphorism of Hippocrates, that " Of two impressions occurring together, not on the same spot, the stronger effaces or obscures the weaker." Accordingly it is probable, that an external will for a time obscure an internal impression, and the following consequences will result.

Involuntary actions, according to the views of Whytt and Bichât, proceed from impressions received by the organs; but these impressions being obscured or suspended, the efforts that result from them will be suspended also; or the organ no longer experiencing the usual irritation, no longer exerts the usual resistance, but relaxes and suffers itself to become distended by the fluids within. Thus it may be conceived how change of feeling causes change of action, an external obscuring, according to Hippocrates, an internal impression.

This solution accords at least with the phenomena; but at all events the laws of external and internal impressions are founded on facts which remain equally true, whether their explanation appear conclusive or doubtful.

Grateful Impressions.

That pleasurable feelings should produce effects opposite to what result from those that are painful, might reasonably be expected; and accordingly it will be found, that while the latter excite resistance, the former dispose the organs to relaxation, or yielding.

When indeed the impression is external to the part that experiences its influence, whether it be grateful or painful, this relaxation might be expected to follow, upon the principle

before stated, of one impression obscuring or effacing another; but pleasing impressions appear to dispose the organs to relaxation, whether external or internal, as will be seen in the following examples.

The stomach shews no signs of resistance when it receives the food, but gradually relaxes for its admission. The impression made on the salivary ducts and secreting vessels by the food taken into the mouth, which increases the flow of saliva, may operate either according to the general principle just stated of external suspending internal feelings, or it may occasion relaxation of vessels and increase of secretion by the pleasurable sensation attending. Warmth evidently disposes to relaxation; and the grateful feeling it excites appears to co-operate with its physical influence in producing this effect; for the relaxation often spreads more rapidly and penetrates more deeply, than the physical influence could possibly reach. Gentle friction often assists in allaying spasms in the limbs, and applied to the abdomen alleviates cholic in the intestines, or spasmodic affections of the womb. The practice of shampooing employed in India, seems nearly allied to friction in its mode of operation, and strongly disposes to relaxation and sleep. The impression of the child at the breast of its mother is of a pleasing nature, and increases the secretion of milk probably for this reason, by promoting relaxation in the lacteal vessels and ducts. Many other instances of relaxation ensuing from grateful impressions might be adduced, but no example occurs of resistance arising from them, unless it be when the distension, which in some organs is occasioned by a suspension of their habitual efforts of resistance, becomes excessive and painful. Then the primary relaxation may be succeeded by a convulsive effort of contraction, as occurs in the stomach when it is over distended with food, or as eructations arise after eating, when this organ becomes swollen by the evolution of air.

Organic Sympathy.

The influence of corporeal impressions, as before stated, is not always confined to the part which receives them, but often extends to others remote from and seemingly unconnected

with it. This participation is termed sympathetic, and its cause has long been esteemed one of the most intricate problems of physiological science.

The prevailing opinion ascribes all sympathetic changes to nervous influence; and since nerves constitute that part of the organic frame which is most immediately essential to the support of sensation and motion, it is almost self-evident that they must also be concerned in producing sympathetic changes of sensibility and mobility.

But admitting nerves to be the immediate agents in producing these sympathies, this general principle is insufficient to account for each particular instance, as ably illustrated by Dr. Whytt, who points out numerous examples in which no peculiar nervous connection can be traced; thus, dimness of sight sometimes proceeds from a disordered stomach, yet no connection appears between the nerves of these organs. And again, if there were such a connection, why does not this effect always attend indigestion.?

The phenomena termed sympathetic, are too multifarious to be explained upon any one single principle. Some may be called sympathies of sensation, as the sense of itching on the skin, occasioned by a disordered stomach; others consist in sympathetic change of action, as sickness at the stomach and vomiting arise from morbid irritability of the womb at the beginning of pregnancy; others may be called sympathies of secretion, as a flow of tears proceeds from irritating the nostrils, or a discharge of mucus from the nose is caused by dust getting into the eye; some again consist in sympathetic affections of the sensorium, as convulsions are liable to occur in infants from irritation of the gums when cutting their teeth; or as confusion of ideas results from the impression of narcotics taken into the stomach.

But however various may be the changes of function produced, or whatever the way in which distant parts manifest their participation, one circumstance appears to be common to all of the instances that will be adduced; and this is, that they all have their immediate seat in the vascular system.

This point, if established, will be a material step towards

ascertaining the nature of this participation; its cause will be subsequently investigated.

Unless it be denied that heat, redness, and swelling denote increased or altered circulation, it will not be doubted that the following instances, which are commonly called sympathetic, have their immediate seat in the capillary vessels.

A general glow or redness is diffused over the surface of the body from immersing the feet in hot water; while a general paleness from contraction of the capillary vessels results from plunging them in cold water. A sympathetic glow is produced in the face by taking cordials into the stomach, while paleness and shrinking of the superficial vessels attend the operation of an emetic. Swelling of the cheek often arises from sympathy with a decayed tooth. Swellings of the glands in the groin often proceed from suppressed gonorrhea, or sympathetic tumours under the arm from whitlow in the finger. Redness in one eye is often occasioned by inflammation in the other. General fever arises from local inflammation.

The nature of these changes clearly bespeaks altered circulation, and betokens that they have their immediate seat in the capillary vessels.

Secretion and exhalation are so obviously vascular functions, that their sympathetic affections cannot be denied to proceed from altered circulation, as in the following instances.

Increased secretion from the salivary glands is promoted by taking any thing savoury into the mouth. Flow of tears from the lachrymal glands proceeds from irritating the membrane of the nose; and discharge of mucus from the nose arises from an irritating cause, as a grain of sand getting into the eye. Perspiration is produced on the surface by taking warm liquids into the stomach; and when the body is overheated, cold liquids have the same effect. A cold damp spreads over the face from the action of emetics taken into the stomach. Diarrhæa often arises from cold applied to the surface, or to the lower extremities. Hemorrhage from the lungs may be checked for a time by cold applied to the chest; and immoderate discharge from the uterus may be stopped by cold applied to the abdomen.

The nature of these also declares that they have their immediate seat in the capillary system, and bespeaks them to be really instances of vascular sympathy.

The following may at first appear more ambiguous, but when duly considered, will also be found analogous in their nature: they consist in changes of sensibility, or in feelings sympathetically awakened, without any direct causes of irritation being applied to the part; thus,

A sense of itching at the nose is occasioned by worms in the intestines, and itching at the extremity of the urethra arises from stone in the bladder. A tickling in the throat and short cough attend ulceration in the lungs. A sense of heat in the throat, called heartburn, arises from acidity in the stomach; and acrimony in the bowels is apt to produce itching on the skin. An aching pain in the knee arises from disease in the hip joint. A sense of weight or dragging is felt at the back and in each groin from certain affections of the womb. And a pain is felt at the shoulder from disease in the liver.

These sympathetic feelings are usually regarded as errors of perception, by the mind referring to one part an impression made upon another; as itching appears to proceed from the toes after the foot has been amputated.

Now this fact does certainly prove that errors of perception may occur, but does not prove that all sympathetic feelings are such. In the case of worms causing itching at the nose, there is sufficient evidence that a change of circulation does actually occur and extend along the whole course of the alimentary canal, producing different effects in different parts; on the tongue, altered secretion and a furred appearance; in the throat, a short cough; in the stomach, vitiated secretion, and altered appetite; in the intestines, slimy stools, and moreover fætor of the breath attends, and also itching at the nose and at the rectum. Thus it appears that the sympathy is not exclusively confined between the nose and the intestines, but that a change extending from one extremity of the mucous membrane to the other, excites the sense of itching on those parts only which are exposed to the air and covered with cuticle, as the nose, the throat, and the rectum.

It was formerly shewn, that each part not only has a mode of feeling peculiar to itself, but also that these feelings are awakened without any external cause being applied to each organ, whenever the circulation is increased to a certain degree; thus, flashes of light are produced in the eye, and continued noises in the ear, by increased circulation in the head. And in the same way, altered circulation along the course of the mucous membrane awakens the sense of itching in those parts of it which are endowed with this mode of feeling.

That errors of perception may occur, appears from the instance already mentioned; but the cases are not at all analogous. When the mind refers to the toes an impression made on the stump, the error consists in referring to the extremity of the nerve an irritating cause applied somewhere in its course. But what nerve, it may be asked, takes its course from the intestines to the nose? The cases are in fact no way parallel; and the real explanation in the case of worms appears to be that already offered, namely, change of circulation manifested in different parts by different changes of function.

In the other instances the same reasoning is applicable; altered circulation being still the immediate cause, although this change may occur in parts not exposed to view, or may not be perceptible to the eye. Thus, the itching produced on the surface by acrimony in the bowels, may not be attended by a visible determination to the skin, but is often followed by a nettle-rash. In the pain of the knee from disease in the hip, no visible redness occurs, as the change is too deeply seated, the periosteum being, from the nature of the pain, its most probable seat, and the depending position of the limb its cause. The dragging pains felt at the back and in each groin from affections of the womb, appear to arise from the stretching of the ligaments which support this organ, causing a tenderness, or state of sub-inflammation at the place of their insertion. The pain in the shoulder from disease in the liver, probably proceeds from the membranes connected with that organ, as the older writers have long since explained it; and it is sometimes increased by pressure, which shews an actual change in the part affected.

As altered circulation operates in a similar manner on the mobility, and the sentient faculty, producing alike an augmentation of each; so the following, which are instances of morbidly increased mobility or inordinate action appear equally referable to this cause or increased circulation, though the seat of the change may be sometimes doubtful.

In the voluntary organs, chorea, characterized by morbid mobility, appears often to proceed sympathetically from irritation in the bowels. Tetanus, or the tendency to tonic spasms, is known to arise from a wound in the foot, or from slight laceration of fibrous membranes. General convulsions are produced in infants from the irritation of the gums in cutting their teeth. In this last instance, the sensorium appears to be the immediate seat of the sudden congestion of blood sympathetically occasioned; in the two former cases it is probable the spine may be the seat of the change.

The involuntary organs present numerous instances of sympathetic participation in altered mobility; thus, the stomach sympathizes with the increased irritability of the womb, and occasions sickness at the beginning of pregnancy. Cholic in the intestines often arises from cold applied to the surface. Spasmodic affections of the womb are apt to proceed at particular periods from cold applied to the lower extremities. Spasmodic asthma is sometimes brought on by a disordered stomach, and frequently by sudden exposure of the surface to cold.

These instances are likewise all attended with some change of secretion, which further confirms their connection with altered circulation.

The last to be noticed are affections of the mental powers sympathetically occasioned by impresssions on distant organs.

Confusion of ideas or intoxication, arising from hurried circulation in the brain, may be quickly produced by a large dose of alcohol taken into the stomach. Stupor, coma, or apoplexy, is the consequence of increasing the dose. The same effect may be produced by injecting a solution of opium or some other narcotics into the intestines, or into the cavity of the abdomen. Syncope, or sudden failure of the mental powers,

from diminished circulation in the brain, results from the impression of certain poisons taken into the stomach, or applied to distant parts; in the same way that paleness in the face arises from emetics acting on the stomach or purgatives on the intestines; and fainting indeed is apt to attend in this case, if their action be too powerful.

Whatever then be the organ sympathetically affected, or whatever the change of function produced, the immediate cause of that change appears to be altered circulation. If the brain sympathize a change of the mental powers attends; if the organs of motion, change of mobility; if a sentient organ, change of sensibility; if a secreting organ, change of secretion results, the cause being the same in all, but the effect different.

Allowing the vascular system to be the immediate seat of the changes produced, two questions remain to be answered: first, why altered circulation in one organ causes altered circulation in another; and, secondly, why one organ is more liable than another to participate in this change at certain times and in particular individuals.

As the capillary vessels owe their powers of action to nervous influence no less than other moving organs, so nerves must also be regarded as the ultimate agents in producing change of vascular action; but the first question is, why this sympathetic tendency prevails more particularly in the vascular system?

If the circumstances be considered that most eminently contribute to the ready participation of one part in the altered feelings or actions of another; or, to express it otherwise, which promote perhaps the more rapid diffusion or propagation of nervous influence, these circumstances will appear to be, similarity of structure and function between the parts, and uninterrupted continuity of connection.

The influence of similarity of structure and function appears in a variety of instances, as shewn in Bichât's Treatise on the Membranes. Thus, rheumatism in the muscular system, gout in the ligaments and tendons, scrofulous swellings in the glandular system, catarrh in he mucous membranes, dropsy in the cellular membranes, eruptive diseases on the skin, afford

examples of change rapidly spreading from one part to another of similar structure, while others more contiguous but of different structure are scarcely if at all affected.

The influence of uninterrupted continuity of connection in promoting the rapid diffusion of nervous influence, or the ready participation of distant parts, appears also in various instances; thus, the pleura of one side has a continued connection by the mediastinum with that of the other, and with the pericardium; beyond which its affections do not readily extend to other serous membranes, disjoined, though similar in structure as to the peritoneum. The mucous membrane has a continued connection over the whole internal surface; hence its affections are rapidly propagated along this canal, as in the case of worms; but they are more readily communicated along parts immediately connected, as from the stomach to the œsophagus, and from the larynx to the lungs, than to parts disjoined, though more contiguous and of similar structure, as from the larynx to the œsophagus, or from the lungs to the stomach. Eruptions on the skin shew also the influence of continuity of connection in the rapid progress they often make over the surface, as in erysipelas; and dropsical effusion illustrates the same point in the cellular membrane.

Now there is no class of organs so conspicuous in these respects as the capillary vessels. In regard to structure and function, the vascular texture has the same general character to whatever part it belong. And in respect to connection, their continuity is uninterrupted in parts of the same texture, and often united by anastomosing vessels between parts of different texture; but where the connection is interrupted the sympathy is less conspicuous.

How change of action in one part is liable to affect others, or how a local change of circulation becomes general, may be easily conceived.

The vascular system receives at the same instant in all parts the impression of the blood sent by the heart; and all parts exert simultaneously an equable resistance to that impression; and thus an uniform distribution of the circulating fluids is maintained. But now a local impression exciting increased

resistance in one part, if sufficiently extensive or considerable, causes the increased effort to become general; as the shrinking of the capillaries of the stomach in nausea or vomiting excites a general sympathy and thereby causes an universal shrinking and paleness.

The next question is why one organ is more liable than another to participate in change of circulation at particular times and in different individuals.

The reasons of these particular sympathies may be classed under three heads; namely, permanent causes of sympathy which always prevail; periodical causes, which operate only at certain ages; and accidental causes, which are peculiar to certain individuals.

Permanent sympathies will be readily understood from the principles already established, arising out of the connection of parts.

As nerves are the ultimate agents in producing vascular as well as other action, it may be readily conceived why parts that derive their nerves from the same source more readily sympathize in change of circulation than parts which derive them from different sources. Hence the internal viscera, deriving their nerves chiefly from the gangliac system, sympathize more conspicuously with each other, than with the voluntary organs, which derive their nerves from the brain. Hence the action of the heart is sooner altered, and the pulse more affected by internal than by external inflammation. In like manner, the stomach participates sooner in affection of the viscera, and vomiting attends inflammation of the intestines, kidneys, uterus, but not inflammations of the surface or limbs.

Periodical sympathies, or those which occur only at particular periods of life, proceed from circumstances, which render certain organs more irritable at these times than others, and therefore more liable to be affected by general causes.

Dr. Cullen has shewn that each organ has a more active circulation, and consequently it has a higher degree of sensibility and mobility about the period of its arrival at maturity; and as this occurs not simultaneously but to different parts in succession, each in its turn will shew the strongest tendency

to sympathetic affection. In infancy it will be the head, hence the liability to convulsions in infants. In childhood the throat will be the sympathizing organ; hence the liability to sore throat and croup before the change of voice occurs. At the age of puberty the lungs are most irritable; hence the liability to consumption at this time. At more advanced age the abdominal viscera; and towards the decline of life the lower extremities become most subject to morbid change; and thus each part at its respective period most strongly evinces the tendency to sympathize.

Lastly, the occasional sympathies are those which arise from a variety of accidental circumstances rendering one organ weaker and more susceptible of impression than others, and hence more subject to be sympathetically affected. Thus original structure or hereditary conformation, organic weakness left by previous disease, or peculiarity in the habits of life of different individuals, may so far modify the phenomena, that exposure of the surface or the lower extremities to cold and wet, will produce in one person catarrh, in another rheumatism, in a third gout, in a fourth asthma, in a fifth pleurisy, in a sixth diarrhæa, in a seventh dropsy, and so on.

Thus it must appear that effects which are subject to perpetual fluctuation cannot be ascribed to a permanent cause such as peculiarity of nervous connection; nor do they admit of explanation upon any one single or general principle.

Art. III. *On the Theory of Spherical Atoms, and on the relation which it bears to the Specific Gravity of certain Minerals* *By* J. F. Daniell, *Esq. F. R. S. and M. R. I.*

Having had occasion, in pursuit of my inquiry into the structure of crystalline bodies, to refer to the Micrographia of Dr. Hook,* in which work that ingenious philosopher suggests the probability of the spherical form of the ultimate molecules of crystals, I was particularly struck with the clearness and

* Hook's Micrographia, 1667.

precision with which he points out the inductive process by which we may hope to obtain an insight into the recondite mechanism of this department of nature. After treating of the cause of sphericity generally, and of the modifications which the sphere receives from different circumstances, he proceeds to prove, that as it is the simplest of all solids, so are its different combinations the basis of the regular polyhedrons which we meet with in nature. He demonstrates the possibility of rudely imitating some of the more simple arrangements by the disposition of a *company of bullets*, and then sketches the following masterly and philosophic-method of verifying the hypothesis.

"Nor have I hitherto found, indeed, an opportunity of prosecuting the inquiry so far as I designed, nor do I know when I may, it requiring abundance of time, and a great deal of assistance, to go through with what I designed, the model of which was this:—

"1st. To get as exact and full a collection as I could, of all the differing kinds of geometrick figured bodies, some three or four several bodies of each kind.

"2d. With them to get as exact a history as possibly I could learn, of their places of generation or finding, and to inquire after as many circumstances that tended to the illustrating of this enquiry as possibly I could observe.

"3d. To make as many trials as, upon experience, I could find requisite in dissolutions, and coagulations of several crystallizing salts, for the needful instruction and information in this enquiry.

"4th. To make several trials on divers other bodies, as metals, minerals, and stones, by dissolving them in several menstruums, and crystallizing them, to see what figures would arise from those several compositions.

"5th. To make compositions and coagulations of several salts together into the same mass—to observe of what figure the product of them would be, and in all, to note as many circumstances as I should judge conducive to my inquiry.

"6th. To inquire the closeness or rarity of the texture of those bodies, by examining their gravity and their refraction, &c.

"7th. To inquire particularly what operations the fire has

upon several kinds of salts—what changes it causes in their figures, textures, or energies.

"8th. To examine their manner of dissolution or acting upon those bodies dissoluble in them—the texture of those bodies before and after the process—and this for the history. Next for the solution. To have examined by what and how many means, such and such figures, actions, and efforts, could be produced possibly; and lastly, from all circumstances well weighed, I should have endeavoured to have shewn which of them was most likely, and (if the informations by these inquiries would have borne it) to have demonstrated which of them it must be and was."

The experimental part of this plan has been in progress ever since the days of Dr. Hooke, and the attention of different crystallographers has been chiefly directed to those very points which, his sagacity foresaw, must constitute the basis of the inquiry. This coincidence is particularly remarkable with respect to certain very recent discoveries, which undoubtedly were totally independent of these suggestions.

1st. In the direction to make *compositions and coagulations of several salts together into the same mass, to observe of what figure the product of them would be,* we cannot but observe the general idea of a train of experiments which have lately furnished M. Beudant with some striking results.*

2d. We may trace an anticipation of my own experiments upon solution, in the recommendation *to examine the manner of dissolution or acting upon those bodies dissoluble in them, and the texture of those bodies before and after the process.*

And 3dly. A like coincidence may be observed in the proposal *to inquire the closeness or rarity of the texture of these bodies, by examining their gravity, &c.,* with some experiments which I propose presently to detail.

Nor have attempts been wanting to solve the problem for which these observations and experiments were recommended

* Recherches tendantes à déterminer l'importance relative des formes cristallines et de la composition chimique, dans la détermination des espèces minérales, par F. S. Beudant.

by Dr. Hooke, and instituted by his successors. It has been shown *by how many, and what means, such crystalline forms might be produced possibly*, and it remains in completion of his plan, to shew *which is the most likely, and if possible, to demonstrate which of them it must be and is.*

In a former paper* upon this subject, I endeavoured to demonstrate, as the consequence of some experiments upon solution, that the hypothesis of spherical and spheroidal particles, fulfilled the necessary conditions deducible from mechanical and chemical dissection united; and on the other hand, I attempted to shew that the supposition of polyhedral atoms was inconsistent with the phenomena observable in the symmetric disintegration of certain crystallised bodies. I propose, in the following pages, to strengthen these conclusions by further arguments and experiments.

In this pursuit I shall take two things for granted: first, the great fundamental law of attraction that all the particles of matter attract one another directly as their masses, and inversely as the squares of their distances; and secondly, that a body of any shape will attract a particle of matter any where, with the same force and in the same direction, as if all the matter of the body were collected in its centre of gravity.

Now the arrangement of octohedral particles adopted and most ingeniously supported by M. Haüy, is in direct opposition to this established principle. Fig. 1, represents an octohedron compounded of six smaller octohedrons, touching one another by their edges, and leaving eight tetrahedral interstices, according to the principles of this structure. But if attraction be exerted in direct proportion to the masses, any two octohedrons should combine by their faces, as in fig. 2, and not by their edges, as in fig. 3. Again, if attraction be in inverse proportion to distance the centres of the two atoms, fig. 3, are further apart than the centres of the two atoms fig. 2.

Are we not bound to draw the obvious conclusion, that the structure of octohedral atoms represented in fig. 1, is impossible?

* Journal of Science, &c. Vol. I. p. 24.

On the contrary, nothing can be more happy than the complete agreement of the spherical hypothesis with this one of the best established and most fundamental of the laws of nature. We find, as I have pointed out in another place,* that the perfectly spherical particles attract one another equally in all directions, while the spheroidal atoms exert their mutual influence in inverse proportion to the lengths of their varying radii. The tracing of this principle through the varying forms of the same body, and the calculations of the powers of the different modifications of the spheroid, present an almost exhaustless field of research. I hope to prove at some future time, that I have not been idle in this course of inquiry, but I shall confine myself at present to the consideration of the properties of those bodies whose constituent particle is the perfect sphere.

Amongst the *differing kinds of geometrical figured bodies* with which we have become acquainted, by means of the *exact and full collections which have been formed* for this purpose, we may remark a certain class which always affect the same form, and the same changes of form, and these may collectively be considered as the simplest of geometric solids. For example, if we observe a substance crystallized, in the shape of a regular octohedron, it is almost certain that the same substance may also be found in the form of a cube, a regular tetrahedron, &c. and *vice versâ.*

From *the history of these* substances we learn, that although they have certain changes of figure in common, these figures differ from one another in the direction in which they yield to mechanical division. Of two bodies crystallized in the octohedral form, one shall be divisible parallel to its own triangular faces, and the other parallel to the faces of a circumscribing cube.

Now, *for the solution* we can shew, that all these interchangeable figures may be produced by various compilations of spherical particles. Before we can be entitled to draw the conclusion that they are so produced, we must also shew that the varying

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* Journal of Science, &c. Vol. I. p. 43.

results of their division can be accounted for upon the same hypothesis. I subjoin a table of such substances, which will at once shew the forms which are common to the class, the particular forms under which each substance has been observed, and the direction in which it is inclined to yield to mechanical division. The authorities from which its materials have been extracted, are the works of Haüy and Jameson.

Of these substances, we may observe, first, that eight yield by division, the regular octohedron, and nine, possessing more or less malleability, are sectile in every direction, and may be referred to the same class, as the most simple in their elementary construction. Five are divisible parallel to the faces of a cube, and two seem to unite both cube and octohedron. Two present indications of joints, parallel to the faces of a regular tetrahedron. One exhibits the cleavage of a rhomboidal dodecahedron, and one both of the dodecahedron and octohedron.

With respect to the octohedral cleavage, I have pointed out, in a former paper,* that it is the natural consequence of the principle of construction therein adopted.

The cubic cleavage, I shall endeavour to shew, may be satisfactorily explained by a different arrangement of similar atoms. If we suppose ten similar spheres, endued with equal powers of attraction, simultaneously exerting their powers upon each other, their forces would be most equally balanced in the cubic form, producing a compact and stable arrangement. If, from some predisposition of affinity, the particles of any solution continue to combine in this definite proportion, a number of cubes will be formed, which again attracting each other, will unite side by side according to the general laws which we have observed. Fig. 4. represents a compound cube of this construction, and it is evident that mechanical force would resolve such a solid into a number of smaller cubes, for upon the planes of junction the spheres of one cube are only held to the spheres of another cube by the simple binary attraction of two particles for each other, while in every other direction, each ball is in contact with three others at least.

* Journal of Science, &c. Vol. I. p. 41.

Such an arrangement will fulfil all the conditions of a cube divisible into cubes, but how shall we form an octohedron upon the same principles? Fig. 5 represents a cube of spheres divided into halves. These halves reversed, and then united, form half the pyramid fig. 6. the triangular faces of which are inclined together at the same angles, as those of the pyramid of a regular octohedron. Although fig. 6 appears to be an eight sided figure, truncated at the summit, yet if we imagine this arrangement infinitely extended, the triangular faces will continue to increase in surface, while the borders will always be composed of two particles, and the truncation of four —so that these surfaces remaining a constant quantity, while the others, are infinitely increased, and the particles themselves being infinitely small, they will be inappreciable in the comparison. Fig. 9 represents an octohedron, constructed upon this principle upon the compound cube, fig. 4, and it is obvious that the principle of combination which forms the six pyramids, placed upon the six faces of the cube, is the very same as that which unites the parts of the cube itself: and such a solid would be divisible by cuts crossing one another at right angles.

Fig. 7 represents the skeleton of the regular tetrahedron, as it exists in the same compound cube: its structure is exactly analogous to that of the octohedron, and it is divisible in the same direction. The surfaces of these figures are not perfectly even, as they are in the corresponding forms of the octohedral structure, but the inequalities of neither of them amount to the depth of a single particle, and therefore with infinitely small atoms, they must be wholly imperceptible. In a former Paper I pointed out the way in which the octohedral and tetrahedral structure were both in fact combined in one; and having now given an example of the corresponding parts of the cubic arrangement, it is obvious that the whole class of solids which can possibly result from one principle, may also be raised upon the other. Fig. 10 represents the rhomboidal dodecahedron upon the cubic, and fig. 8 the same solid upon the octohedral construction. They furnish good illustrations of the structure of complex figures.

Having thus, I trust, satisfactorily shewn that the octohedral and cubic cleavage of certain crystals may both be completely explained upon the hypothesis of spherical atoms, it is easy to understand the few instances in which we find the two combined in the same substance. We must bear in mind that when M. Haüy speaks of obtaining the primitive form of a substance by mechanical division, that he does not strictly mean that he has in every instance extracted such a nucleus, but that he has concluded from certain cuts or even sometimes from certain natural fissures in given directions, that the mineral would be divisible in those directions till by the union of the newly generated planes such primitive form would be produced. It is upon such indications only that both cleavages have been ascribed to pyrites and tungsten; both of them substances which yield with much difficulty to any regular division. It is not opposed to reason, but on the contrary, highly probable *à priori*, that a combination which necessarily includes the octohedron in its structure, should sometimes exhibit indications of its existence; especially, when we reflect that it is by no means essential to the theory to conceive that in every instance the constituent cubes are of the simplest possible combination as in fig. 4; larger and more compound cubes, including of course larger octohedral nuclei, may be supposed to unite; the necessary consequence of which must be traces of a double structure.

The two instances of tetrahedral division both occurring in the ores of copper, we can have no difficulty in classing with those of octohedral arrangement. The instances in which they vary from the simplest of all forms are very rare, and then it is even questionable, whether they do not owe that variation to a different proportion of their elementary ingredients.

The only two remaining instances in the table, present an anomaly which I cannot at present quite satisfactorily remove. These are the metal antimony and the sulphuret of zinc. The first of these indeed I should have little difficulty in classing with the rest of the metals as divisible in nearly every direction. M. Haüy himself thus speaks of it: " La structure de l'antimoine est le plus compliquée que j'aie encore observée. Quoique les joints naturels fussent très sensibles comme il y en avoit dans

vingt directions différentes, la percussion qui n' en mettoit à découvert qu'une partie sur un même fragment faisoit naître des combinaisons qui varioient sans cesse, d'où résultoient différens solides plus ou moins irréguliers; en sorte qu'il n'étoit pas facile d'apercevoir le terme où devoit aboutir la division mécanique, dans le cas où elle eût présenté l'ensemble de toutes les faces cachées dans l'intérieur de la masse."

From all things considered, however, he draws the conclusion that it is divisible parallel to the faces both of an octohedron and a rhomboidal dodecahedron.

Of blende M. Haüy observes that the primitive form is a rhomboidal dodecahedron, and that " Les joints naturels sont très faciles à saisir." Now I certainly have not yet discovered a reason, why any combination of spherical particles which I have yet seen should be divisible in this direction; but, when we recollect, first, the difficulty there is in performing the experiment, especially with such a substance as the one of which we are now treating, and, secondly, that eight of the twelve sections are those of the octohedron, it is not too much to say, that there may possibly have been some mistake in this solitary exception to our theory. I have never myself been able to obtain any good results in my attempts to dissect the sulphuret of zinc.

But from the abstract contemplation of the theory of spherical particles, I have been led to a series of experiments, the result of which amounts as nearly to proof of its correctness as the nature of the subject seems to admit of.

We have often had occasion to remark the difference between the octohedral and tetrahedral structure of spherical particles, and that the same substance will sometimes furnish specimens of both by dissection. The confirmation to which I allude is founded upon the consideration of these circumstances.

Figs. 11 and 12 represent a tetrahedral and octohedral pile of balls both composed of triangular faces, the bases of which are constituted of four particles. The tetrahedron is contained by four of these similar and equal planes, and the octohedron by eight; so that the whole superficies of the latter is exactly double that of the former. Now it is obvious that solids so constructed must differ in their specific gravities unless the

number of elementary particles in the octohedron be exactly double the number in the tetrahedron; that is to say, unless the number of atoms in a given space be equal in both arrangements. But it will be found that the tetrahedron, fig. 11, is composed of twenty spheres, and the octohedron, fig. 12 of fourty-four; the latter containing more than double the number of particles under a double surface. The specific gravity of the latter solid must therefore be greater than the specific gravity of the former. Here then is at once a method of verifying our hypothesis. In fluor spar we have a substance, which by its ready mechanical division will furnish both the required solids, and the theory supposes them to differ in the same way as the two piles of balls in their composition. The question therefore seems to resolve itself into this—is the specific gravity of a mass of fluor split into the form of an octohedron greater than the specific gravity of the same mass split into the form of a tetrahedron?

To determine this question, I proceeded to try the following experiments, with all the care and attention which the delicacy of the investigation required.

I selected a mass of green fluor spar, transparent, and perfectly free from the adhesion of any foreign ingredient. From this I extracted, by mechanical division, the following solids—a tetrahedron—a rhomboid—an octohedron, and a cuniform or lengthened octohedron. I then proceeded to take their respective specific gravities with a very delicate balance, making use of every precaution to avoid any source of error. They were as follows.—

Cuniform Octohedron	-	3.100
Octohedron	-	3.037
Tetrahedron		2.909
Rhomboid	-	2.904

The result of this experiment was therefore perfectly satisfactory, the specific gravity of the octohedral arrangements exceeding that of the tetrahedral in a very sensible degree. To confirm this conclusion in a still more unexceptionable manner, I proceeded as follows.

I selected a cube of colourless and perfectly transparent fluor-spar, and took its specific gravity, 3.180. I then cut off four of

its corners, and again weighed it. Its specific gravity had increased to 3.242. I then went on dividing it till I had completed the octohedron, and found its specific gravity again increased to 3.261. Three of the solid angles of the cube remained entire, and the specific gravity of these I found to be respectively, 3.115—3.111—3.125.

I can conceive nothing more convincing than these facts. Here we have the very same solid of perfectly homogeneous composition, varying in its different parts in specific gravity, according to the calculations of theory, while nothing could be more unexpected than the fact itself, till the calculations pointed it out as a test whereby the hypothesis must stand or fall. I will here restate the result in a tabular form.

Spec. gravity of the cube	-	3.180
4 corners cut	-	3.242
Octohedron	-	3.261
1st corner	-	3.115
2d ditto	-	3.111
3d ditto	-	3.125

It is not necessary to state the particulars of numerous other experiments of the same nature which I have tried: it will be sufficient to observe that they all agreed in the result, that fluor-spar increases in specific gravity according as, in its division, we approach to the perfect octohedral arrangement, and recede from the tetrahedral.*

I had no sooner substantiated the fact of the variation of specific gravity, according to the mechanical arrangement of the constituent atoms of crystals, than I perceived that the same criterion might be applied to ascertain the justness of the distinction which I had already drawn between the octohedral and cubical arrangement. I found it, however, much more difficult

* I would recommend to those who have access to good collections, either public or private, to try these experiments with the different forms of diamonds. The purity of the substance seems in a great measure to obviate the objection to which other solids would be liable, if not cut from the same original mass.

to bring this class of bodies to the test, it being scarcely possible to select unexceptionable specimens. Pyrites crystallized in the octohedral form, of sufficient size for the experiment, is a very rare mineral, and when obtained, not easily divisible into cubic particles. Neither is it very easy to find octohedral galena with neat surfaces and free from the admixture of foreign particles. After much pains, however, I succeeded in obtaining specimens of the latter substance, which afforded me the following satisfactory results.

The first specimen was an octohedron, whose faces were perfectly neat and smooth, and which readily broke into cubes with a shining even fracture and high lustre. The specific gravity of the octohedron was 7.558
of the cube - 7.584

A result diametrically opposite to that afforded by fluor spar, in which the octohedron is the heavier particle and the cube the lighter. The second specimen was also an octohedron but not of smooth surfaces, it being apparently made up of a number of small cubes which left step-like inequalities upon its faces. It also readily broke into cubes with an even and highly metallic fracture. The specific gravity of the octohedron was 7.564
be 7.703

The last specimen was a cubo-octohedron of galena, which was peculiarly fitted for the experiment from being perfectly isolated from any gangue, and complete in its form. It readily broke into cubes in the direction of the diagonals of its cubic faces. The specific gravity of the cubo-octohedron was 7.513
cube 7.611

These results agree exactly with the peculiarities of the structure which I have ventured to suggest in explanation of the properties of those bodies which assume all the external forms of the octohedral arrangement, but are divisible only in a direction parallel to the faces of a cube. For it is obvious from the simple inspection of the figures 5 and 6 that the particles which compose the two halves of the cube are more closely compacted when in the cubic form than when reversed, they constituted part of the summit of an octohedron.

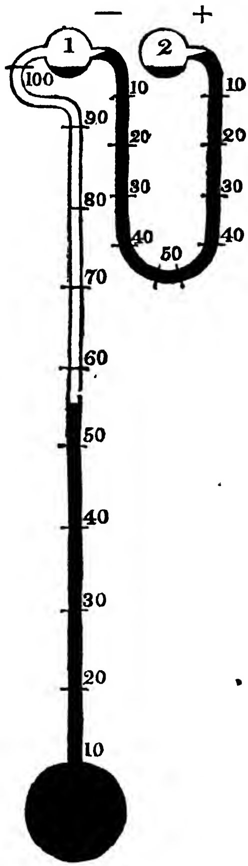
Thus, then, by *enquiring the closeness or rarity of the texture of these bodies,* have we been lead to a striking confirmation of one of the two prevailing theories of crystallization, and this confirmation is so decided, that we may almost venture to affirm, that in conjunction with former illustrations, we have not only shewn *which of them was most likely,* but have actually demonstrated *which of them it must be and is.*

The same method of enquiry is applicable to those bodies whose constituent particles are modifications of the spherical form. I have already obtained some curious results from this class of bodies, which I shall reserve for a future paper, when I may be able to confirm them, and to state them in a more perfect form. This part of the subject is far more complicated and difficult, but it is full of interest and novelty.

In conclusion, I shall just venture to observe, that if the theory of spherical atoms shall be thought to derive any confirmation from these observatious, that it is well worthy of the consideration of mineralogists in general, whether in their future labours it may not be more useful to observe and record the irregularities and anomalies of crystals, or rather, I might say, to represent them as they really are in nature, than to imagine in them a regularity and symmetry which does not in truth exist. It is highly desirable that the regular polyhedral forms to which each substance most constantly tends, should be accurately described; but I cannot conceive it of minor importance that the minute traces should be marked which are the more delicate results of the same general laws.

ART. IV. *Suggestion of a new Principle for the Register Thermometer. By* MARSHALL HALL, *M. D. &c. of Nottingham.*

THE form of the register thermometer, which it is the object of this paper to describe, is represented in the annexed outline:—



The lowest bulb, a part of the thermometric tube, and the whole of the register tube, are to be filled with rectified spirit of wine, as denoted by the shaded part of the figure.

The upper part of the thermometric tube, and the two register bulbs, are to be occupied by atmospheric air, except that a small portion of spirit may remain at the lowest part of each of these bulbs, in order to supply the register tube, should the thermometer be adjusted for experiment, at unusually high or low temperatures. The thermometer is to be sealed, and totally excluded from the atmosphere.

The air in the upper part of the thermometric tube, and in the two register bulbs, will always preserve, or immediately regain, an equal degree of density and elasticity in each. The action of changes in the external temperature on the two register bulbs, being equal, will occasion no movement of the fluid in the register tube. But the elevation or depression of the spirit in the thermometric tube, will act primarily in augmenting or diminishing the density and elasticity of the air in the *first* register bulb; this change of elasticity will be immediately imparted to the air in the *second* register bulb, an effect which implies a proportional movement of the fluid in the register tube.

From these premises it will appear, that if the register thermometer be exposed to an increased or diminished temperature, the fluid in the *register* will be moved in consequence of the elevation or descent of the spirit in the *thermometer*, and by these movements of the thermometric fluid only. If the register thermometer be exposed to an increased temperature, the fluid rises in the thermometric tube, the air in the first register bulb is compressed, and its elasticity consequently increased; this increase of elasticity will be immediately imparted to the air in the second register bulb, and into this latter bulb, a quantity of the spirit contained in the register tube, proportionate to the increase of temperature, will be forced. If the register thermometer be subjected to a diminution of temperature, the fluid in the thermometric tube descends, the air in the first register bulb is expanded, and its elasticity diminished; the air in the second register bulb re-acts, and force a portion of the spirit contained in the register tube, into the first bulb. From these bulbs the spirit

cannot return into the register tube whilst the register thermometer remains upright, as may be seen by inspecting the figure.

The spirit in the *thermometer* always denotes the *actual* temperature. The quantity of spirit which has passed from the register into the *second* register bulb, represents the *highest*, and the quantity of spirit which has passed from the register into the *first* register bulb, represents the *lowest* temperature which has intervened during the absence of the observer. These quantities are ascertained by observing the number of degrees in each part of the register tube found *empty* after the experiment. For the highest intervening temperature, the number of degrees found empty in the part of the register tube under the second register bulb, (marked +), are to be *added* to the actual temperature. For the lowest intervening temperature, the number of degrees found empty in the part of the register tube beneath the first register bulb, (marked —), are to be *subtracted* from the actual temperature.

All the tubes are to be graduated by *experiment*, the *whole* instrument being, for this purpose, exposed to determinate temperatures. They are all graduated with the same facility, and by the same number of experiments, as the simple thermometer, as will be manifest on a little reflection.

To *readjust* the register thermometer for a new experiment, the instrument is to be simply inclined, so as to allow the spirit which had passed into the two register bulbs, to flow back into the register tube. For this end, the tube employed for the register thermometer, is to be of the smallest caliber, which will readily admit of the spirit trickling down its side in repassing the included air; and the thermometric tube is curved at its upper part, to prevent the spirit contained in it, from flowing into the first register bulb, when the instrument is placed in this inclined position. The register thermometer is then to be left in an upright position for experiment.

Should the situation of the fluids become deranged by accident or carriage, which will not be easy, nor take place in a considerable degree, they may be replaced by properly in-

clining the instrument, and, if necessary, by subjecting one or other of the register bulbs to the heat of a candle, as the occasion may require.

When the minuter indications of the register thermometer are required, as in ascertaining the temperature of lakes or of the sea, at different depths, a tube of a minute caliber may be employed. The instrument is then to be readjusted by inclining it, and by warming first one and then the other register bulb, so as to bring the fluid in the register tube, into contact with that in each of these bulbs; and lastly, by bringing the two bulbs to the same temperature, before the thermometer is placed upright for experiment.

But without employing a tube of smaller caliber, the indications of the register thermometer may be rendered more accurate by increasing the size of the thermometric bulb, which may be made long and cylindrical, and by diminishing that of the two bulbs of the register.

If it be apprehended that the register thermometer may burst on being exposed to high temperatures, it may be sealed whilst the inclosed air is in a state of slight rarefaction.

Nottingham, August 13, 1817.

Art. V. *A short Account of Horizontal Water Wheels.* *By* W. Adamson, *Esq.*

On perusing the works of mechanical writers, it appears, that many attempts have been made to construct horizontal water wheels, on such a principle as would give them sufficient power for mechanical purposes; but that these attempts have often failed.

The principal kinds, of which we have any account, are—

1. Such as have their vanes or floats placed round the rim, like those of a wind-mill, and which are made much broader than the vein of water which is to strike them; the water is delivered from a spout, which is so directed as that they may be struck in a direction perpendicular to their surface.

2. Those which have their floats ranged round the rim of the wheel in planes inclined to the radius, but parallel to the axis.

3. Those which have the floats standing on a soal, or on the side of the rim, not pointing to the axis, but aside from it, so that they will admit of the spout being more conveniently placed.

4. The centrifugal wheel, commonly called Barker's mill.

This consists of an upright pipe or trunk, communicating with two horizontal arms, each having a hole near the end, opening in opposite directions, and at right angles to the arms. The water is poured from a spout into the top of the trunk, and issues through the holes in the arms, with a velocity corresponding to their depth below the surface of the water, by which the arms are forced backwards, and a retrograde motion is given to the wheel.

5. In the year 1797, a patent was taken out by Mr. Robert Beatson, for a method of constructing horizontal mills to go either by wind or water. The machine consists of four rectangular frames or wings, standing at right angles to each other on an upright shaft. The floats, which consist of some thin light substance, are fixed in the frames parallel to the horizon, and are so constructed, that when they face the wind or the current of water, they are shut, and fill up the whole space within the frame, but on the opposite side, when they return against the current, they are open, and permit the wind or water to pass between them.

This machine, as a water mill, was intended to act in the current of a river, or by the ebbing and flowing of the tide.

These seem to be the principal kinds of horizontal wheels, and from the nature of the principles upon which they act, it is evident their powers must be very small.

It however appears, that many are in use on the Continent of Europe.

An Explanation of the New Patent Horizontal Water Wheel, and the Principles of its Action.

A circular wall, in the form of a hollow cylinder, is built in a perpendicular position on a horizontal plane.

Through the side of the cylinder, at the bottom, several rectangular cuts or passages are made, the sides of which are perpendicular to the base, or bottom of the cylinder, and the length of each within, is about four times the width. Fig. 1, Plate 3.

The passages or cuts, are made quite round the circumference, and so near to each other, that the sections of their sides within, make an acute angle, and leave, between each two, a solid part in the form of a wedge, the edge of which is perpendicular to the base, so that a line drawn from the centre of the wheel to it, will form a right angle with that side of the cut which faces the centre. Fig. 1.

Within the cylinder is placed the horizontal wheel, with floats, and a perpendicular axis or spindle, which turns on a point in the centre. Fig. 1 and 2.

The floats FF are rectangular planes, fixed round the edge of the wheel in planes passing through the centre, and perpendicular to the plane of the wheel. Their height is something greater than that of a cut, and their breadth rather more than its width: also their number may be about three times the number of cuts. But for the purpose of obtaining the most regular motion, the numbers of the cuts and floats ought to be prime to each other. Fig. 2.

The cylinder is surrounded by a reservoir of water, supported by a circular wall, which, in low falls, may be equal to its depth. Fig. 1.

The reservoir is filled, from the canal or river, by a stream flowing through a head or slit at the top of the outer wall, and at the bottom, the water flows through the cuts PP against the floats, and turns the wheel. Fig. 1 and 2.

The width of the cylinder within, is continued downwards below the floats, to a depth sufficient for permitting passages to be made under the reservoir, of sufficient capacity to take away the water as fast as it enters the inner cylinder. Fig. 2.

The passages at the bottom of the machine, shewing the escape of the water, appear in the plate, for the want of room, to occupy only half the circumference, but ought to be continued quite round. Fig. 2.

In fig. 2. where part of a perpendicular section of the machine is represented, the passage of the water appears to be only on one side, but the opposite side is supposed to pass through one of the solids which supports the reservoir and wall.

The wheel, to about half the radius, is open quite round the centre, for the purpose of permitting the free passage of the air; (this, in a large wheel, may be much more than half) the remainder is solid, quite round, and curved or dished on the under side, for the purpose of turning the water downwards, and preventing it from rising above the wheel, as it passes from the float, in a thin sheet to the centre, where it forms a head, which by its pressure, facilitates its escape. Fig. 2.

According to the manner in which the floats are fixed in the wheel, they ought, in the figure, to be invisible, but are made to appear, for the purpose of shewing the nature of the action of the water against them. Fig. 1.

To find what depth the bottom passages ought to be, it will be only necessary to know the breadth and depth of the head through which the water flows into the reservoir, as the same quantity must pass both places in the same time.

The perfection of this machine may be shewn as follows:

1. The floats being open on all sides, except that opposite the centre, will prevent, as much as possible, any re-action against the water coming in.

2. The space below the floats, and the passages from it, being always sufficient to take away the water as fast as it enters, will prevent any accumulation of tail water from impeding the floats.

3. The velocity of the water being greater than that of the wheel, prevents any impediment by centrifugal force.

4. The force of the water through the cuts, arises from its perpendicular pressure from the surface to the centre of force, and therefore is the greatest possible.

5. The line of pressure against the floats, is as nearly perpendicular to their surface, and as near to the extremity of the radius, as it is possible to make it act against the floats

of a wheel, and therefore the pressure against them cannot be greater.

6. The water acts against all the floats at the same time.

7. The whole of the water acts against the floats.

8. The water receives no check from the want of air.

9. No water wheel can move with less friction.

Hence it must be evident, that these principles will give the greatest power that can possibly be obtained from the action of water upon a horizontal wheel:

But as a wheel acting on these principles has never before been tried, it was thought most advisable to put it to the test by experiment, previous to making it public. A very complete and perfect model, (or rather a little mill) has therefore been made by Messrs. Bramah and Sons, at their manufactory in Pimlico, near London.

The Model

Stands on a base of two feet diameter, and its height is 53 inches.

The outward cylinder, which supports the water in the reservoir, is of cast iron.

The inner cylinder, in which the wheel moves, is of wrought iron, and its lower end, through which the cuts or water passages are made, is of brass.

The depth of the reservoir is about 51 inches.

The number of cuts or water passages is 24, and their depth 1 inch.

The wheel and floats are of brass.

The diameter of the wheel is 12 inches, and the number of floats is 79, a prime number.

A mahogany wheel or pully of equal diameter to the wheel is fixed on the top of the spindle, and above it one of about 6.8 inches diameter, is fixed for the purpose of making experiments.

The water escapes at the bottom quite round the machine.

Experiments.

With this model, or mill, the following experiments were made.

When the reservoir was full to above 4 feet above the centre of presure, or middle point in the cuts, the wheel made nearly 4 revolutions in a second, and, as no weight was then suspended, this was its greatest velocity.

A cord was then fixed to the smaller wheel, and passed over a pully, with a weight suspended, when 12 revolutions of the wheel made in

$$\left.\begin{matrix}25\\13\\6\\5\end{matrix}\right\}\begin{matrix}\text{Seconds}\\\text{raised}\end{matrix}\left\{\begin{matrix}12\\10\\8\\6\end{matrix}\right\}\text{Pounds, 21 feet, or}\left\{\begin{matrix}50.\ 4\\96.92\\210.\\252.\end{matrix}\right\}\begin{matrix}\text{Feet in a}\\\text{minute.}\end{matrix}$$

Then each weight multiplied by the height to which it was raised in a minute gives the momentum; therefore

$$\left.\begin{matrix}12\times 50.\ 4 = 604.8\\10\times 96.92 = 969.2\\8\times 210. = 1680.\\6\times 252. = 1812.\end{matrix}\right\} = \text{the momentum.}$$

Hence it appears, that the 3d experiment produced the greatest effect, and that the wheel then made 12 revolutions in 6 seconds, or 2 in one second, and therefore it moved with nearly half of its greatest velocity. Consequently, when the wheel moves with nearly half of its greatest velocity, it works to the greatest advantage, supposing the 3d experiment to be the maximum.

Diameter or Size of the Wheel.

This wheel may be made of any diameter that may be required for making a given number of revolutions in a given time.

Velocity.

The wheel may move with any velocity whatever that can be obtained from the fall.

Mr. Banks, at page 105 of his Treatise on Mills, by taking a mean of the experiments made by six different authors, for the purpose of finding with what velocity water will issue from a fall of a given depth, gives 5.4 × square root of the depth = velocity of the water.

But according to these experiments, 6 comes much nearer than 5.4, and also agrees exactly with the experiments made

by Banks himself; and as, in these experiments, it gives nearly the velocity of the wheel, therefore 6 × square root of the depth = velocity of the wheel, and this may also, in practice, be taken for the velocity of the water without any material error, though its velocity will always be something greater than that of the wheel when moving without resistance.

On these principles a small wheel with a high fall will move with a velocity amazingly great. Thus, let the diameter of the wheel be 1 foot, and the height of the fall 89 feet, then $6\sqrt{89} = 56{,}60388$ feet, the velocity per second, and as the circumference of the wheel is 3.1416; therefore

As 3.1416 : 1 :: 56.60388 : 18 revolutions per second
or $18 \times 60 = 1080$ revolutions in a minute.

Power.

In the specification, the power of the horizontal wheel was compared to that of the overshot, on a supposition that the force of a stream of water acting against a perpendicular plane near the orifice from which it flows, is nearly equal to the weight of the column which impels it, as Mr. Banks has proved by experiment.

But in making some experiments for the purpose of ascertaining the manner in which the water acts against the floats of the horizontal wheel, it appeared,

That if a stream of water from a horizontal pipe, act against a perpendicular plane near the orifice with any considerable force, it will spread quite round in a thin sheet parallel to the plane, and leave it on all sides in that direction; and

That if the edge of the stream be brought a little beyond the edge of the plane, so that part of it may pass by, it will form an angle with it; and that as the further side of the stream approaches the edge of the plane, the angle will encrease until they coincide, when it will become a right angle.

Hence it is evident, that there is a reaction in this machine against the water coming in, which it is impossible to avoid, and that this is what reduces its power below that of the overshot wheel; but that this re-action is very different from the centrifugal force.

Before we proceed to compute the power of the wheel, it is necessary to observe, that when the radius is 1, the width of a cut is equal to the natural versed sine of the angle between two of them, taken at the centre, and therefore,

If the versed sine of the angle between two cuts be multiplied by any given radius, the product will be the width of a cut to that radius, and since all the cuts, in any cylinder, are equal in width, as they are also in depth; therefore,

If the versed sine of the angle between two cuts be multiplied by the radius, and then by the number and depth of the cuts, that is versed sine $\times$ radius $\times$ number $\times$ depth, it gives the area of a rectangular section equal to the area of the perpendicular sections of all the cuts.

In the model the radius is 6 inches, the number of cuts 24, and depth 1 inch, the angle 15°, and its versed sine .034074; therefore

$$.034074 \times 6 \times 24 = 1 = 4.906656 \text{ square inches,}$$

which, in consequence of the cuts having been made rather wider by dressing, is taken at 5 square inches or $\frac{5}{144}$ square feet, and the water being 4 feet deep, its velocity was $6\sqrt{4} = 12$ feet per second;

Hence, $\frac{5 \times 12}{144} = \frac{5}{12}$ cubic feet of water issue in a second, or $\frac{5 \times 60}{15} = 25$ cubic feet in a minute.

Therefore for the power, we have 25 cubic feet, or 25×62.5 pounds of water descending through 4 feet in a minute; hence

The momentum of the power is $25 \times 62.5 \times 4 = 6250$.

Then to find the momentum of the effect, according to Mr Smeaton's method;—when the wheel moved without water, a weight of 10 ounces give it a velocity of 2 feet per second. Therefore according to the 3d experiment, the weight raised was 8 pounds 10 ounces, or 8.625 lbs.; consequently,

The momentum of the effect was $8.625 \times 210 = 1811.25$ and as 6250 : 1811.25 : : 1 : 2898 the effect. But if the velocity of the water be found according to Mr. Banks's mean of

the experiments of six different authors, it will be 10.8 feet per second, and the effect will be 322; and this makes the power of the horizontal wheel double to that of the undershot, according to the 2d example in Mr. Smeaton's Table.

Remark.

Mr. Smeaton, at page 12 of his Treatise on Mills, gives an account of an experiment on the undershot wheel, where it appears that his head, or fall, of water was 30 inches, and that 264.7 pounds weight of water was expended, or descended through 30 inches in a minute; hence,

The momentum of the power was $264.7 \times 30 = 7941$, that 9.375 pounds weight of water was raised through 135 inches in a minute by the wheel; hence,

The momentum of the effect was $9.375 \times 135 = 1265.625$, therefore as $7941 : 1265.625 :: 1 : .1594$ the effect, and $.1594 \times 2 = .3188 =$ double the effect.

But it appears, that Mr. Smeaton has inserted 32 in his Table as the true effect in this case, on a supposition that the same effect may be obtained from half the power, and he therefore multiplies the weight of the water expended in a minute by 15, or half the depth, instead of 30, which was the depth through which the water, that turned the wheel, actually descended in a minute.

Had he made such a discovery as this, he ought to have given a demonstration, or a clear proof of its truth; for his argument about a *virtual head*, certainly gives no such proof; on the contrary, he says, that he has obtained more than double of what is assigned by theory; and that this is very different from the opinions and calculations of authors of the first reputation.

The reason of making this remark is, that it is probable the power of the horizontal wheel will be compared with that of the undershot, according to Mr. Smeaton's Table, where he has inserted double the power of the undershot wheel (or very near it) according to his own experiments.

The horizontal wheel may be used in any fall however high or low.

In low Falls.

Example. Let the depth of the fall be 2 feet, diameter of the wheel 20 feet, number of cuts 24, and their depth 4 inches;

Then, by the Table, the angle between two cuts is 15°, and its versed sine .034074; therefore,

$.034074 \times 10 \times 24 \times \frac{1}{3} = 2.72592$ square feet, or the area of a rectangular passages equal to that of the perpendicular sections of all the cuts.

This may therefore be considered as the base of a column of water, the height of which is the perpendicular distance from the surface to the centre of pressure or the middle point of the cut, which in this case is 22 inches, or $\frac{11}{6}$ feet; hence we have

$2.7592 \times \frac{11}{6} = 5$ cubic feet, nearly $= 5 \times 62.5 = 312.5$ pounds weight constantly impelling the water through the cuts against the floats quite round the wheel, and 312.5 divided by 24, gives 13 pounds for each cut or passage. The greatest velocity of the wheel will be $6\sqrt{\frac{11}{6}} = \sqrt{66} = 8\,124$ or about 8 feet per second, and therefore when it works to the greatest advantage will be 4 feet per second. Then as $4 : 1'' :: 20 \times 3.1416 : 15.7''$ time of a revolution.

In high Falls.

In order to obtain the full force of the water here in the same manner as in low falls, the height of the walls of the reservoir would require to be equal to that of the fall. But,

This however is not necessary, as both the reservoir and inner cylinder may be covered at any proper height, as denoted by the dotted line in the plate, but the reservoir must be made water tight.

A pipe may then be brought from the surface of the water to the bottom of the reservoir, where it must be so fixed that the water may flow from it in the same direction as the wheel turns, which, in that respect, will augment the power.

But as this supplying pipe will be in the place of a reservoir of water, the area of a section of it, ought to be greater than

the sum of the areas of the perpendicular sections of all the cuts, and it ought also to be constantly full up to the top, otherwise the water would not be supplied so fast as it could pass through the cuts, and a part of the power would be lost, unless there were a contrivance for covering or shutting up part of the cuts.

Example. Let the depth of the fall be 81 feet, diameter of the wheel 10 feet, number of cuts 30, and their depth $\frac{1}{2}$ a foot.

Then, by the Table, the angle between two cuts will be 12°, and its versed sine .021852 ; therefore,

$.021852 \times 5 \times 30 \times \frac{1}{2} = 1.6389$ square feet, which is the area of a rectangular passage, equal to that of the perpendicular sections of all the cuts, and the diameter of a circular pipe of equal area will be 17.3 inches, therefore the diameter of the supplying pipe must be greater than this.

If the radius of the wheel and depth of the cuts remain the same, the greater the number is, the less will the area of the whole of their perpendicular sections be, and consequently, the less water will pass through them, but it will act nearer to the circumference; and therefore, in proportion to its quantity, will produce a greater effect.

Example. Let the numbers be 12, 16, 30, 50, then these multiplied by their respective versed sines will be

$$\left.\begin{array}{l} 12 \times .133975 = 1.6077 \\ 16 \times 076120 = 1.21792 \\ 30 \times .021852 = 0.65556 \\ 50 \times .007885 = 0.39425 \end{array}\right\} \text{which are the ratios of the sums of the areas of their perpendicular sections.}$$

Hence, when the quantity, or supply of water is great, the number of cuts must be small, and, on the contrary, when it is small, the number of cuts must be great in order to obtain the greatest effect.

TABLE shewing the angle between two cuts with its natural versed sine from 9 to 52.

	Angle.	V. sine		Angle.	V. sine
	° ″			° ″	
9	40 0	.233956	31	11 36.79	.020470
10	36 0	.190983	32	11 15.	.019215
11	32 43.63	.158746	33	10 54.55	.018071
12	30 0	.133975	34	10 35.29	.017027
13	27 41.54	.114544	35	10 17.14	.016070
14	25 42.86	.099031	36	10 0	.015192
15	24 0	.086454	37	9 43.78	.014384
16	22 30	.076120	38	9 28.42	.013639
17	21 10.59	.067528	39	9 13.85	.012950
18	20 0	.060307	40	9 0	.012312
19	18 56.81	.054183	41	8 46.83	.011720
20	18 0	.048943	42	8 34.28	.011169
21	17 8.57	.044427	43	8 22.33	.010657
22	16 21.82	.040507	44	8 10.91	.010179
23	15 39.09	.037083	45	8 0.	.009732
24	15 0	.034074	46	7 49.56	.009314
25	14 24	.031417	47	7 39.57	.008923
26	13 50.77	.029058	48	7 30.	008555
27	13 20	.026955	49	7 20.82	.008210
28	12 51.43	.025072	50	7 12.	.007885
29	12 24.83	.093379	51	7 3.53	.007580
30	12 0	.021852	52	6 55.39	.007291

W. Adamson, Ebury-street, Five fields, Chelsea,
20th August, 1817.

Art. VI. *On the Geographical Distribution of Ferns. From the Latin of* Alexander, *Baron* von Humboldt. *Paris.* 1817.

It will not escape the studious observer of the natural stations of plants, that in the cryptogamous* class of vegeta-

* *Phænogamous* plants, are those in which the organs of fructification are apparent and determinate; *cryptogamous* plants, those

bles, the Order of Ferns distinguishes itself from those of Mosses, Liverworts and Mushrooms, in this particular, viz. that the latter have many species which are owned in common as well by the North of Europe as by the tropical regions of both the Old and New Continents, and not merely as peculiar to the mountains, but likewise as inhabitants of their plains; such are FUNARIA *hygrometrica* (twisting cord-moss), DICRANIUM *glaucum* (white fork-moss), POLYTRICHUM *juniperinum* (juniper-leaved hair-moss), and the Lichens VERRUCARIA *Perella*, STICTA *crocata*, PARMELIA *perlata*, &c. all which are found as well on the trees and rocks of the West Indian Islands, the chain of the Andés, the East Indies, and that part of New Holland which stretches towards the North, as in the Forests of Sweden and Great Britain. While among ferns a far narrower range has been allotted to the species, for with very few exceptions those of the new and old continents not only differ in the one from those in the other, but in the tropical regions are manifestly distinct from their coordinates of the temperate and frigid zones.

In tracing the native stations of the ferns and the plan of their distribution over the face of the earth, I have ascertained that of the 1000 species that have been as yet observed, 760 belong to the torrid zone and 240 to the temperate and frigid zones. But when we speak generally of the number of these plants, the subject presents itself three ways; one, regarding the relative numbers of the species among themselves, another regarding their numbers in relation to the phænogamous portion of vegetation, and a third in regard to the quantity each species may of itself exist in. Thus Walehnberg reckons 19 species of fern in Lapland, Hoffmann, 40 in Germany, Swarz, 103 in Jamaica, making the proportions of the frigid, temperate, and torrid zones, as they relate to each other in this point, as 1, 2, and 5. But the amount of phænogamous plants

where these are more or less clandestine and indeterminate; *agamous* plants, those in which those organs either are not present, or have not been detected. *K.*

in these regions is greatly disproportionate; for in Lapland there are 514 known species, and in Germany 1884, making the proportions 1 : 25 and 1 : 48. Whether this relative disproportion increases towards the equator or not, is unknown to me; but if it were 1 : 50, and if the ferns have come as completely within the view and observation of botanists as the phænogamous portion of the vegetable creation, (which has hardly been the case*), the result would be, that 5000 phænogamous species have been already discovered in Jamaica, and 23,000 in the whole of the tropical extent of America. The degrees of abundance with which nature has sent forth particular species are manifestly various: at the extremity of Norway, on the shores of the frozen sea, ferns, although but few in species, cover nearly the whole face of the land.

Of the 1000 species of ferns recorded by Wildenow, 470 grow in the old world; viz. 170 in the temperate and frigid zones, 300 within the tropics; and 530 grow in the New World, viz. 70 in the temperate and frigid zones, and 460 within the tropics.

I have eslewhere attempted to shew, that if we represent the land within the tropics by = 1000, we are to allot it in the following proportions; to

Africa, - - - - -	461
America - - - - -	301
New Holland and the Islands in the Indian Sea,	124
Asia - - - - -	114

leaving the proportion which belongs to the New World in relation to that of the Old as 5 is to 7. So that if we did not know the New World to be of a more humid constitution with a more mountainous surface than the Old, and that the interior of Africa and new Holland have been far less explored than the regions that lie between the Orinoco and the river of the

* Swartz, who attended diligently to ferns, has only recorded 764 phænogamous plants in Jamaica. In Michaux's Flora of North America 45 ferns and 1575 phænogamous plants have been described. The Isles of Bourbon and France comprehend 137 species of plants.

Amazons, we might be led to wonder why the portion of America, being considerably the least, should have by $\frac{1}{3}$ the largest proportion of ferns.

I am fully aware that too much reliance must not be placed on the exactness of the amounts, since it has not been ascertained, what proportion of each of the various regions of the earth has been accurately explored; nor what proportion of the total of vegetation has escaped the notice of the botanist; nor whether all the different tribes of plants have been investigated with equal care. But independant of these doubts, it is clear that the number of species cannot at all events be less than that which I computed.

Although the phænogamous plants of tropical America are entirely different from the phænogamous ones of the Old World, yet the northern portion of America has many in common with Europe and the North of Asia. Whence it may be inferred, that at some period those continents have joined towards the North Pole; and it will be a matter of wonder, that so few European ferns are found in Canada, Pensylvania, and California; for of such we do not hear of more than from 6 to 10 species, as for instance, OPHIOGLOSSUM *vulgatum* (common adder's-tongue) POLYPODIUM *calcareum* (rigid three-branched polypody), ASPIDIUM *thelypteris*, (marsh shield-fern, or Lady-fern), *A cristatum* (lesser crested shield-fern) PTERIS *aquilina* (common brake), &c; but then Europe altogether does not contain more than 70 indigenous species of fern.

Towards the South Pole, the ferns, which grow at the extremities of the two continents, differ more than those of the northern temperate zone do from each other. The only instances of any common to all the continent in those regions, that I am aware of, are DAVALLIA *pinnata*, which grows in Chili and in the Phillipine Islands; and OSMUNDA *barbara*, which grows in New Holland and at the Cape of Good Hope. Hence it is the more strange that ASPIDIUM *aculeatum* (or common prickly shield-fern), which is the only one among the ferns of the Old World that ranges through several of the zones, extending itself from England across Mount Atlas to the southernmost verge

of Africa, should not have yet been met with in America. According to Messrs. Forster and Brown, BOTRYCHIUM *Lunaria* (common moonwort) familiar in every part of Germany, covers, in company with the PHLEUM *alpinum* (alpine cat's-tail-grass) of our country, every rock in Tierra del Fuego. HYMENOPHYLLUM *tunbridgense* (Tunbridge filmy-grass) grows in New Holland as well as in Ireland, Norway, and Italy.

The only instance of a species of the fern-tribe growing both in the Old and in the New Continents, in the torrid as well as in the frigid zone, in a northern and a southern hemisphere, viz in England, Jamaica, and the Isle of Bourbon, is the ADIANTUM *Capillus Veneris* (true maiden-hair), a plant which has been commemorated by Hippocrates, Theophrastus, and Dioscorides. It has however been surmized by some that the germs of this fern have adhered to the filtering stones used aboard ships in long voyages, and been thus carried along with them and disseminated over the world.

It is not quite clear, that any fern has been found that is common to the tropical regions of both the New and Old Continents. Authors have as yet only suggested three such instances, viz. ASPIDIUM *punctulatum*, A. *coriaceum* and ASPLENIUM *monanthemum*, which are said to be spontaneous in the West Indies, the Andés of Peru, Guinea, New Holland, and the Cape of Good Hope. To these may be added ASPLENIUM *falcatum*, and BLECHNUM *caudatum*, supposed to belong to South America and the Islands of Magindanao as well as Ceylon. But I doubt whether the statements concerning these instances are so well authenticated, as those mentioned above of HYMENOPHYLLUM *tunbridgense*, and BOTRYCHIUM *Lunaria*.

More than half of all the ferns yet observed belong to four genera only, viz. to POLYPODIUM (Polypody), ASPIDIUM (Shield-fern), PTERIS (Brake) and ASPLENIUM (Spleenwort). Some types among them seem confined almost entirely to tropical lands, as MENISCIUM, ANEMIA, HYDROGLOSSUM, MERTENSIA and SCHIZEA : but all the generic types of the northern temperate zone are found likewise between the tropics. The New World alone has no genus of the Fern-tribe peculiar to itself, although many of its phænogamous genera are so; for example, CACTUS, CALCEOLARIA, ALSTRŒMERIA, BROMELIA,

and others. As for the fern-types Polybotrya, Pleopeltis and Marattia so few species of them have been found, that it is highly probable other congeners will be detected in our own continent, so that they can hardly be relied on as exceptions.

Ferns, which in the northern frigid zone grow along the ground in the shade, in the tropical regions, shoot up to the dimensions of trees, vying with the palms themselves in stature and comeliness. These tree-ferns constitute a principal ornament of the torrid zone, giving that peculiar character to the spots where they grow, which strikes so forcibly the European stranger by its novelty. The Greek and Roman writers who have treated of plants, mention in several places, that many which in Europe creep along the ground, in hotter climates become trees, making it the more remarkable, that none should speak of a tree-fern; particularly as Megasthenes, Aristobulus, and Nearchus, recount among the wonders of Indian and Ethiopian lands, that there are trees having leaves as large as a shield, a fig-tree that takes root at the ends of its branches, and palms too high for the flight of an arrow to pass over. Theophrastus, Dioscorides, and Pliny who has trodden over again the ground of the two first, mention only eight or ten species of ferns, none above a yard high. And when a certain sort of fern brought from India is noticed, as being known to the philosopher Eresius, no observation is offered concerning the stature of the stem, attention being only bestowed on certain medicinal qualities imputed to the plant. So that tree-ferns must have beenleft unnoticed by the Romans and Greeks, either because in that portion of India, which the arms of Alexander had opened to them, or in Ethiopia and Lybia, which they visited in the view of commerce, none are to be found; or because their writers, as was usual in former times, left unnoticed all plants which did not recommend themselves to their attention by the fruit they bore, or the fragrance of their wood, or their medicinal virtues. Oviedo, the Spaniard, in his History of the West Indies, is the first who mentions a tree-fern; for the *Filix arborea* of Tragus is nothing more than a variety of our common forked spleenwort, transplanted into a more fertile land.

So late as the time of Linnæus scarcely 4 sorts of tree-fern

were known, and about 15 sorts of palms; at present we are acquainted with 25 of the former, and 100 of the latter. The tree-ferns of America are,

> CYATHEA *speciosa*, *C. arborea*, *C. Serra*, *C. muricata*, *C. multiflora*, *C. villosa*, *C. aspera*, PTERIS *aculeata*, *P. villosa*, MENISCIUM *arboreum*, ASPIDIUM *caducum*, *A. procerum*, *A. rostratum*, ASPLENIUM *arboreum*, cæt.

Of New Holland and the Islands of the Indian Sea;

> CYATHEA *affinis*, *C. medullaris*, *C. dealbata*, *C. extensa*, DICKSONIA *squarrosa*, *D. antarctica*, cæt.

Of Southern Africa, and the Islands of France and Bourbon,

> CYATHEA *excelsa*, *C. glauca*, *C. riparia*, cæt.

The tree-ferns of the East Indies, Cochinchina, the Island of Madagascar, and the Cape of Good Hope have not yet been accurately described. I have not included amongst the arborescent species, ASPIDIUM *Arbuscula*, LOMARIA *Boryana*, POLYPODIUM *rhizocaule*, *P. pruinatum*, PTERIS *marginata*, &c. because they are either climbers, or else shrubby or caulescent plants, with stems not more than three or four feet high. Of the five new species of tree-ferns observed by M. Bonpland and myself, CYATHEA *speciosa* is the one which makes the finest appearance, and has a stem 25 feet high. The *C. excelsa* of the Isle of Bourbon is said by Messrs. Du Petit Thouars and Bory St. Vincent to grow to the same height.

In general, the tropical plants are further advanced towards the South Pole than towards the North Pole, a fact which seems inconsistent with the received opinion of the cold being greater in the Southern Hemisphere. In North America and New Spain, the tree-ferns hardly ever grow beyond the limits of the tropic of Cancer, while only one species of palm (CHAMÆROPS *Palmetto*) advances to Carolina, or the latitude of 37°.

In the Southern Hemisphere, on the other hand, DICKSONIA *antarctica*, described by Labillardiére as having a stem near 20 feet high, grows in Van Diemen's Island; nay, another species of *Dicksonia* has been found at Dusky Bay in New Zealand, in the 46th degree of southern latitude, where in a parallel which corresponds with that of Lyons, the trees swarm with *Epidendra and Dendrobia*, vegetable parasites, which constitute the

most graceful ornaments of the tropical Flora. Phænomena, which excite the more wonder, when we find from the observations of the celebrated navigators Cook, Entrecasteaux, and Flinders, that the mean annual temperature of this zone is scarcely equal to 12,5 of the centigrade thermometer. But the great expanse of water in the Southern Hemisphere cools the heat in summer and assuages the cold in winter; so that in the 52d and 53d degrees of southern latitude, corresponding to that of Berlin in our hemisphere, the snow melts nearly every day of the winter, and the centigrade thermometer very seldom rises to 11° in the months of January and December, the hot summer months of these regions. Even in the 42d and 43d degrees of Southern latitude, owing to the currents of wind that blow from the South Pole, the summers are hardly hotter than at the sides of the mountains of Switzerland: these summers on the other hand are succeeded by winters even milder than those of Rome. Labillardiére never observed the centrigrade thermometer in Van Diemen's Island rise higher at mid-day than 15-17°,5 in the months of January and February; and Cook in the same parallel, during July, a winter month of those regions, never found the degree of cold below 8° of the centigrade thermometer.

In tropical America, as I have shewn in another work, the herbaceous ferns grow in all parts, from the border of the sea, and from the plains, up to the heights of the Andés, although but little below the limits of eternal snow. There are certain species peculiar to certain elevations, and each in its zone is unable to transgress that boundary which has been allotted to it. Thus in the mountains of Peru and New Spain, CHEILANTHES *marginatus*, ACROSTICHUM *muscosum*, and HEMIONITIS *rufa*, grow between the elevations of 1200 and 1600 fathoms: in the same way the PTERIS *crispa* (rock-brake or curled stone-fern) grows on Mount St. Gothard from above the region of Pines up to the elevation of 1,100 fathoms; and in Lapland, near Enontekies, to that of 300 fathoms; so that in Switzerland, its highest station is scarcely 280 fathoms removed from the limits of eternal snow, and in the North of Norway scarcely 100 fathoms. POLYPODIUM *hyperboreum* (hairy alpine

polypody) in latitude 68° advances still higher, to beyond BETULA *nana* (dwarf birch) DRABA *alpina* (mountain whitlow grass) and CAMPANULA *uniflora* (one-flowered bell-flower). I have elsewhere explained myself on the subject of the reason why plants approach nearer to the boundary of eternal snow towards the North Pole, than they do in the torrid zone.

In the kingdom of Quito, M. Bonpland and myself saw mountain-ferns reaching into the elevated plain which engirds Mount Antisana and along the sides of the Rucupichincha in the valley of Verdecuchu, both which spots are 2100 fathoms above the level of the sea; and also other herbaceous ferns on Mount Chimborazo, growing on porphyritic rock, as high up as 2300 fathoms. But at heights so great, where the cold is so severe, as well as in parched unshaded plains and spots, the quantity of ferns is plainly perceived to diminish from the want of moisture. Their main body is stationed in the temperate and sub-frigid zones, between the elevations of 300 and 1200 fathoms.

Tree-ferns in some regions occasionally grow down to the edge of the sea, and on lowlands in shady spots; but in those parts of tropical America where M. Bonpland and myself passed five years, they occupy a peculiar zone, in which the temperature is between 18 and 22 degrees of the centigrade thermometer. A delightful region, where vernal breezes prevail almost the year through, and which lies between the elevations of 400 and 800 fathoms from the level of the sea; though they sometimes descend as low as to the height of 200 fathoms. This zone is called by the natives in the Spanish dialect, *tierra templada de los helechos*, the temperate land of the ferns. The chief part of the tree-ferns we met with, was in New Andalusia, near the Convent of Caripa, and in new Granada near Ibague, Guaduas and Icononzo, and in the vallies of Peru between Loxa and the River of the Amazons, also in New Spain near Xalapa. The region of fern-trees is not far from that of the CINCHONAS, or bark-trees; for we find CINCHONA *oblongifolia* and C. *multiflora*, however fond they are of heat, mingling themselves with the tree-ferns in the Andes of Peru, and of the mountains of Quito and New

Granada. In New Spain they grow in company with the oaks* of that country; a strange association in the eye of the European.

Art. VII. *Report of Mr.* Brande's *Lectures on Mineralogical Chemistry, delivered in the Theatre of the Royal Institution.* Continued from p. 368, vol. iii.

Lecture II.

From the consideration of the *general characters* of minerals, enumerated in the former lecture, we proceed by regular transition, to their *classification* or artificial arrangement, and to their subdivision into *genera* and *species*. In the earlier periods of mineralogy, we find the most obvious and glaring characters of minerals assumed as the basis or foundation of their subdivision. Thus the diamond, the ruby, the topaz, and rock-crystal were brought together into one class, because of their hardness and transparency. Another family consisted of salts soluble in water;—another, of metallic minerals, having lustre, opacity, and high specific gravity. This plan was pursued in mineralogy, while it remained in what may be called its independent state, but the inroads of chemistry soon led to the detection of such gross incongruities in systems of this kind, that a new method of arrangement was speedily devised, in which the chemical characters of the bodies to be classified, were chiefly, and in some cases, exclusively consulted. It was shewn, that the diamond, the ruby, rock-crystal, and the topaz, though something like each other, when hastily and superficially looked at, were extremely at variance in their component parts. The diamond was marked by combustibility, and by producing carbonic acid when burned: it was therefore removed by the chemist from among the earthy gems, and transferred to the inflammable and carbonaceous gems. Rock-crystal, and the ruby, were divorced,

* Quercus xalapensis. *Plantæ æquinoct. ii.* 25.

because the one consists of siliceous, the other of argillaceous earth; and in this way, the propriety, and even necessity of consulting chemical analysis was proved, and has since been adopted as one of the principal foundations of the modern classification of minerals.

The advantage in classifying minerals, to be derived from an examination of their crystalline forms, is also extremely important. I have before alluded to it as the basis of Haüy's arrangement, and during the prosecution of our subject, ample opportunity will occur, of adducing proofs of its value, though it will hardly be expected, that in these lectures, the proposed object of which is to consider mineralogy as a branch of chemistry, I should follow any other than a purely chemical arrangement. It was once customary to speak of metallic and earthy minerals, and although the majority of the earths are now proved to be metallic oxides, this need not interfere with so useful a distinction. Among the metals, for instance, that which prevails, will be considered as the foundation of the genus;—thus we shall have gold, silver, copper, &c. giving rise to so many genera; and in regard to the earthy minerals, the predominating earth will take precedence in giving title to the gems. Thus in the calcareous, aluminous, siliceous, and other genera, lime, silex, alumine, and the other earths predominate, and give character. In the alumino-siliceous genus, alumine prevails over silex, and the reverse happens in the silico-aluminous. In these matters I am not very nice about authorities, or established customs, but aim to adopt that plan which experience has shewn to be most useful and intelligible in conveying my own information to my hearers.

Classes or families then will include minerals bearing general analogies in their component parts, or having some other striking resemblances; thus, the metallic ores—th earthy compounds—saline bodies—and inflammables—form our four classes.

These classes embrace *genera:* thus we have the different metals and earths giving rise to so many distinct genera of minerals.

The *genera* are subdivided into *species*, having similar component parts, and *subspecies*, differing from the species either in form or extraneous admixtures.

Varieties may be assumed from colour or certain accidental circumstances belonging to peculiar specimens.—In the GENUS *copper*, for instance, we observe several SPECIES, such as *native, oxide, chloride, sulphuret, carbonate, arseniate*, &c. In native copper we have the SUBSPECIES *crystallized* and *amorphous*;—of the sulphuret we have a VARIETY which is *iridescent.*

Thus far then in regard to the classification and subdivision of minerals into genera and species, our way is sufficiently clear, and we march on without impediment; but the next subject that asks for attention, in this preliminary view, is beset with a variety of embarrassing accompaniments;—I mean the nomenclature of mineralogy. In every science the system of nomenclature is of first-rate consequence, and the more its bearings and effects are considered, the more obvious will this appear.

In the first place it increases the inducement to study by adding to the harmony and beauty of science, and in scientific pursuits, may be said to occupy nearly the same place as elegance of style in works of imagination. Then it materially facilitates the means as well as the labour of instruction, and is really a royal road to the acquisition of knowledge; and lastly, by abridging the fatiguing powers of reasoning, it leaves the mind more at leisure for the comparison of ideas, and consequently tends to the promotion of new enquiries, and to the extension of the boundaries of science. The truth of these observations is at once obvious by a reference to the new nomenclature of chemical philosophy, which though frequently pushed to extremes, for the caprice of man is always starting from too little to too much, has yet tended to the general diffusion and easy acquisition of the leading principles of that useful branch of kowledge, consequently to its aggrandizement and progress. In praising, however, the new chemical nomenclature, we must recollect, that the science to which it was applied, was in a manner itself new;—that it

had just been liberated from the shackles of alchemical and hypothetical absurdities, and that it was quite impossible under such circumstances, to go on talking of the blue dragons and white eagles of Paracelsus, or of the archæus of Van Helmont, or even the phlogiston of Stahl.

With mineralogy the case is very different, and although the chemical nomenclature is in many cases well applicable to it, there are others in which it is nearly inadmissible. The terms *sulphuret of iron, sulphate of stronthian, subsulphate of alumine*, and *ferruginous oxide of copper*, are drawn from chemistry, and are certainly preferable to the names *pyrites, celestine, rock butter*, and *tile ore*, still retained by the Wernerian mineralogists. But then there are other cases to which this kind of nomenclature does not apply, as where several different earthy bodies are united: and where they are combined with oxides of the common metals, and so on. At least, if we would express these chemically, our words would become of an almost illegible and unmeasurable length. There is a mineral, for instance, in which siliceous, aluminous, and calcareous earths are united with oxide of iron: to this we could not apply any chemical name that would not be ridiculously affected; so we call it a *garnet*, a term derived from the Italian *garnato*, or pomegranate seed.

Simplicity should be among the first objects of the nomenclaturist, and where a name, though objectionable, or even itself unmeaning, has this recommendation—it will generally sustain itself against more learned but complicated combinations of words. Attempts have lately been made to introduce into mineralogy a chemical nomenclature cacophonous and obscure in the extreme, but of its adoption, there is little chance. There is a wide difference between the fabrication of words and the discovery of facts. Yet system makers often seem to forget this, and a student under their tuition becomes so involved in obscure terms, and affected phraseology, as to be left far behind by those who take the more direct and beaten path: they get the evil habit of substituting words for things, and often suffer the fate of the man in the fable, who while he descended the well in search of trea-

sure, was in the mean while robbed of his cloak and all the booty he had before gotten, by his companions who stayed above.

As far as choice of evils is concerned, we certainly have it in the nomenclature of mineralogy. Where we can adhere to the chemical terms, they, I think, are the least exceptionable; but when they cease to be applicable, it becomes difficult to know what to reject or what to adopt. Haüy's nomenclature has been much adopted and extolled. Whenever chemical language is admissible he uses it, but after departing from the beaten track, he gets abroad among fanciful neologisms, often as objectionable as any that have been suggested by the innovating industry of more modern mineralogists. As no general principles have hitherto been resorted to in naming the minerals out of the reach of ordinary chemical language, as there is no *philosophy* in the nomenclature of mineralogy, so it admits not of any general elucidation, and any further observations will be more appropriately brought forward under particular than general heads.

As the metals will form the first objects of discussion, it will be right to take a bird's-eye view of the circumstances under which they are presented to us by nature, and in doing this, I shall confine myself to a plain statement of facts, and then if time allows, notice the hypotheses of geologists to account for the phenomena.

A few of the metals are found scattered through the soil of valleys, or contained in the sand of rivers, or the deposits of the mountain torrents; this has been especially the case with gold. Great quantities of this precious metal have been found in Africa, and all of this description, is picked up by the negroes and brought to market in ostrich and vulture quills. In America too, enormous masses of gold have been found in alluvial soil. In 1730, a mass was discovered in Peru weighing 45lbs. In Scotland, and in some parts of England and Ireland it is met with under similar circumstances.

By far the greater number of the metals however occur in regular fissures which traverse the earth's strata, and which

have been termed *veins*. The nature of the rocks in which these repositories occur, was considered in my Geological lectures. Of these the principal are granite, slate, and limestone, and sometimes a vein occurs between two rocks, so that one wall shall be different from the other. In Cornwall there are veins which thus lie between granite and slate.

Veins containing the metals generally run east and west, and are by no means uniform fissures. but vary considerably in dimensions, sometimes bulging out so as to contain very large masses of ore, at others dwindling down into thin strings which occasionally re-unite so as again to form a good vein. Thus we find veins of variable thicknesses, from an inch or two to 30 feet. The width of 3 or 4 feet is most productive, for when the vein is very large, the relative quantity of useless matter generally increases in it; and always, the metal is accompanied by more or less extraneous matter which has been called the *gangue* or *matrix*, and its nature occasionally enables the miner to form some judgment as to the probable value of the vein or lode.

When a vein is discovered it must not be imagined that the difficulties are few which attend the removal of its treasure; on the contrary, these are so numerous, and so out of the reach of prognostication, as to choke the miner's art with all kinds of obstacles, and render its success a matter of the greatest uncertainty. Sometimes the patches of metal are of little extent, sometimes the ore becomes so poor as not to bear the expense of raising. The veins often vanish into thin strings, which do not re-unite, or a subterranean torrent breaks in upon the works, and in a few hours destroys the labour of years, and annihilates the owner's prospects.

Another interruption often occurs, and the phenomenon is a very curious one; it is called a *cross course*; it is a vein of stony matter which traverses the strata north and south, thus intersecting the metalliferous vein, interfering with its contents, and throwing it so much out of its old course, that it is difficult, and often impossible to find it again, or when found, to pursue it with profit.

Veins seldom begin to be prolific at a less depth than 20 or 30 fathoms, the upper parts being filled with various substances, chiefly the detritus of the surrounding country, and what is extremely curious, the same vein at various depths and in passing through various strata differs materially in its contents.

Sometimes one metallic vein intersects another, and in that case it is obvious that the intersected vein must be of a date anterior to that which intersects; thus some idea may be formed of the relative ages of the different metals.

The methods by which veins are pursued or worked would lead me into too wide a field for present consideration. Shafts or perpendicular borings are first constructed, and from these the veins are attacked at different levels, by horizontal galleries. Of the shafts, some serve for access to the mine, some for ventilation, and in others are draining pumps and machinery for raising the ore.

In searching for veins of metal, various methods have been had recourse to, some of which are founded upon the imaginary influence of the stars, and similar frivolous divinations; others have a more solid basis.

We read of flames dancing over metallic districts, and guiding the miner, not into morasses, like the *ignis fatuus*, but to a substantial repository of metal, and such an appearance connected with such an event, was likely enough to work upon the superstitious, and lead them to refer the phenomenon to the charitable interference of a pro pitious genius. Of this we can give a more plausible explanation by referring it to the passage of electricity carried off from the atmosphere by a metallic vein. In the same way lightning has sometimes made its escape.

The waters of a mining district are constantly contaminated by metallic salts, and their examination may lead to the nature of the metal.

A singular instance of this kind occurred in North Wales. The peat in the neighbourhood of a copper vein was so impregnated with the solution as to leave copper when burned.

Sometimes the water thus contaminated pervades the soil in the neighbourhood of the vein, which thus becomes unfit for the support of vegetable life; so that the sterility of certain patches of ground may be indicative of an emboweled harvest.

Having now put you, in some measure, in possession of the facts to be explained, we may briefly advert to the explanations which have been resorted to, to account for the formation of veins. The older metallurgists seem to have had two notions on this subject. Some contending that what we call a vein was once a chimney by which the fumes and vapours of a central fire made their exit. Others have imagined a mass or root of metal, the branches of which constitute the vein, and have gone so far as to assert the growth of metals, which indeed is no uncommon notion with the vulgar at this day, who are deceived by the appearance which the metals assume when precipitated by each other.

Hutton and Werner have each tried their strength upon the theory of veins.

They agree in the outset by supposing veins to have been originally cracks or fissures in the crust of the earth, but they widely differ in proceeding to fill them; the former geologist conceiving that their contents have been thrown up in the state of igneous fusion from below; the latter, that lapideous and metallic substances in aqueous solution have run into them from above.

That veins have once been open fissures is more than probable, it may indeed be considered as demonstrated by the detritus and pebbles sometimes found in them; and the curious circumstance of rounded pebbles cemented by tin ore, noticed by Mr. Giddy in the Relistian mine in Cornwall, shews the metal to have been crystallised and deposited after the pebbles had taken their station in the vein; but if we grant an empty fissure in a rock, the phenomena which veins present are yet very difficultly explicable either on the Huttonian or Wernerian hypothesis. The contents of a vein are generally arranged in regular layers; now, it is barely probable that this may have happened as was imagined by Dr. Hutton

but how to account for it upon the Wernerian statement, or indeed how to admit the leading positions of that eminent teacher, without the grossest violations of probability, I know not. If a fluid, holding the metal in solution, had run into the veins from above, why did it not deposit its contents in horizontal layers—why not upon the surfaces of the rocks containing veins—or why should it percolate through the superincumbent strata, and yet leave them quite uncontaminated by its contents? Then again, what could have been the nature of a solvent which should hold all the contents of the vein in solution? It must have been gifted with all denominations of opposite powers, at once acid and alkaline, sulphureous and neutral.

If we smile at the universal solvent of the alchemists, at the alcahest, we cannot gravely admit the existence of this vein-filling fluid; but when we are told that it was simple water, confusion becomes worse confounded, and we might as laudably assert that the three angles of a triangle were *once* unequal to two right angles, as that the miscellaneous contents of mineral veins were soluble in water at the time of their formation.

Art. VIII. *On the Sulphuret, the Oxides, and some other Combinations of Platinum. By M.* Vauquelin.

[From the last Number of the Annales de Chimie.]

Many modern chemists have spoken of the sulphuret of platinum, but rather from the induction of analogy than from experience and observation; at least none that I am aware of have described either the process for its formation, or its properties and the proportion of its elements. It is to supply this deficiency that I made the following experiments.

Whilst making the sulphuret of soda, in a platinum crucible, I observed on dissolving the sulphuret in water, that a quantity of black brilliant needles were formed, considerably

resembling the crystallised oxide of manganese. This substance heated red in a platinum crucible, gave out the odour of sulphurous acid, and took the metallic lustre of platinum, losing nearly 16 per cent. in weight. In order to submit the sulphuret to a greater number of experiments, I endeavoured to prepare it in the following manner.

Experiment 1. Ten parts of the triple muriate of ammonia and platinum, very pure, and containing between 42 and 43 per cent. of metal, after being mixed with 10 parts of sulphur and ten of dry subcarbonate of soda, were melted in a platinum crucible, the substance washed with boiling water furnished a black powder in brilliant needles, like the oxide of manganese; this substance, carefully washed and dried, weighed 5.35 parts.

As the salt of platinum could furnish but forty-two hundredths of its weight of metal, it seems evident that this sulphuret contained 21.5 per cent. of sulphur; but as on calcination it lost but 16.5 per cent. of its weight, the platinum crucible must have been acted on, and have furnished a portion of sulphuret, which has been considered as sulphur combined with the platinum furnished by the muriate. Independent of this excess of sulphuret, the hydro-sulphurous solution of soda still contained a portion of platinum, which gave it an intense red colour, even after the sulphur had been precipitated by acetic acid.

Experiment 2. Ten parts of the triple muriate of ammonia and platinum being mixed with twenty parts of sulphur, and heated red in an earthenware crucible well closed, gave also a perfect sulphuret of platinum, which lost 15.5 per cent. by being heated in the open air.

The presence of alkali therefore is not necessary to produce the combination of platinum with sulphur.

Experiment 3. One part of finely divided platinum and two of sulphur, heated in a close vessel, were completely combined. The sulphuret which resulted had a very intense black colour, but had not the lustre of, nor was it crystallised like the sulphurets formed by the other processes, in consequence of its not being fused like them.

This sulphuret did not lose more than 15 per cent. by calcination. It appears, therefore, according to these experiments, that the sulphuret of platinum contains between 15 and 16 5 per cent. of sulphur, and in taking 16, I think we are not far from the truth.

Experiment 4. The sulphuret of platinum heated strongly in close vessels, suffers no other change than a kind of fusion. The simple acids do not act upon it.

Experiment 5. To ascertain whether platinum would combine with a greater quantity of sulphur in the humid way I made the following experiment.

Into a solution of platinum containing as little acid in excess as possible, a current of sulphuretted hydrogen gas was passed until there was a superabundance. The sulphuret was then suffered to fall down, and the supernatent liquor poured off, it was then washed with boiling water, and when dry was of a fine black colour. It lost 23 per cent. by heat and air. It would appear, therefore, that there are two sulphurets of platinum, the one containing 1.5 times as much sulphur as the other.

Experiment 6. But this supposed sulphuret dried at a temperature which certainly would not have permitted the retention of water, furnished by distillation, in a narrow glass tube, which contained a very small quantity of air, a considerable proportion of water and sulphurous acid. After having undergone this operation, the sulphuret resembled in its colour those obtained in the dry way, and lost by calcination in the air 14 per cent.

It is not therefore a simple sulphuret which is formed on the precipitation of a solution of platina by sulphuretted hydrogen, but a compound of the oxide of platinum with sulphuretted hydrogen.

Experiments on the Muriate and the Oxide of Platinum.

Experiment 1. If the common muriate of platinum be heated at a temperature capable of driving off a portion of its acid, this is disengaged in the state of chlorine; the salt becomes of an orange brown colour, loses its taste, its solubi-

lity, and furnishes, by its decomposition at a red heat 72.5 per cent. of metal. This salt not being soluble in water is easily washed for the separation of any common muriate that it may contain.

Experiment 2. This salt submitted to distillation in close vessels, furnished a yellowish green gas, entirely soluble in water, and which was chlorine ; a small quantity of the salt, the weight of which I was not able to appreciate, sublimed into the neck of the retort, and there remained in the body 70 hundredths.

Experiment 3. One hundred parts of the sub-salt acted on by concentrated muriatic acid were dissolved, with the exception of ten parts of metallic platinum which remained at the bottom of the solution. This metal existed without doubt in an insulated state in the salt, and did not result from the action of the acid.

Experiment 4. The above muriatic solution evaporated to dryness with the greatest precaution, to avoid decomposition, furnished a brown residuum, which was almost insoluble in water, and which presented all the properties of the sub-salt before its solution.

It appears, therefore, that the change suffered by the salt, in consequence of the heat, did not consist simply in the evaporation of a part of its acid, but that the oxide itself had suffered an alteration ; this however will be considered more fully afterwards.

The small portion of this salt re-dissolved by water is precipitated black by potash and soda ; mixed with muriate of ammonia it gives but a very small quantity of the ammoniacal muriate of platinum, but by evaporation the solution forms quadrangular prismatic crystals of a purple red colour far more soluble than the common triple ammoniacal muriate of platinum. These crystals dissolved in water are not precipitated, when cold, by soda, like the liquor from which they were formed, but if the mixture be boiled ammonia separates, and a black precipitate is formed. At the end of a certain time this salt becomes brown and opaque, and the crystals at last become covered with a brilliant metallic film. Nothing

of this kind happens to the common ammoniacal muriate; there must, therefore, be a difference between them which is not understood.

The sub-muriate of platinum is not soluble in nitric acid; it scarcely gives a colour to it after long boiling.

Experiment 5. The common muriate of platinum, dried as much as possible, without making it suffer decomposition, gave by a red heat, 47 per cent. of metallic platinum; but it contained, without doubt, free acid and water. It is difficult to draw, from this experiment, any correct ideas respecting the relation of this salt to the one above described.

Experiment 6. 10 parts of submuriate of platinum, and 10 of caustic soda, were boiled in a sufficient quantity of water; a black matter resulted, which, washed and dried, weighed 7,9 parts.

This matter required much washing to separate the alkali, and it is still doubtful, whether it can be perfectly freed from it.

Experiment 7. 100 parts of the black substance, heated in a retort, gave off oxygen, and lost 12 per cent., but the platinum obtained in this operation was alkaline, and when washed with hot water and re-dried, had lost 8 parts; its weight was therefore reduced to 80.

The sub-salt from which this oxide was formed, containing naturally 10 per cent. of metallic platina, and 8 parts of alkali, slightly muriated, renders the quantity of pure oxide operated on, equal to 82 parts. Now, if 82 gave 12 of oxygen, it is evident, that 100 would have furnished 14.63.

Experiment 8. If 100 parts of this black oxide of platinum be acted upon by muriatic acid, a part is dissolved, but there remains a quantity of platinum equal to 20 parts, which reduces the real quantity of oxide to 72, since in its natural state, as we have seen above, it contained but 82 parts, and there has been a further separation of 10 parts during its solution. Thus the 72 parts of oxide dissolved in the muriatic acid, contain the 12 of oxygen, which were before in the 82 parts, and consequently, 100 parts of this oxide will contain $16\frac{2}{3}$ of oxygen, whilst the first contained but 14.63. There is no

apparent relation between these two oxides and the two sulphurets of platinum of which we have spoken, if at least we may regard that as a sulphuret obtained by the action of sulphuretted hydrogen.

Thus much is certain, that the oxide which we have obtained from the submuriate of platinum, by means of soda, contains about 15 per cent. of oxygen, a result which M. Berzelius had already obtained by a different process, which I have repeated in the following manner.

Experiment 9. Into a certain quantity of solution of common muriate of platinum, were put 30 parts of mercury, heat was applied, and the mixture continually agitated, until all the platinum was precipitated, which was easily known by the loss of colour in the liquor. The solid substance was then washed with boiling water, and when perfectly dried, weighed 19.4 parts.

Experiment 10. These 19.4 parts heated in a retort, gave 8.4 of metallic mercury, containing slight traces of the subchloride of mercury, (calomel) and there remained in the retort, 10.34 parts of very pure platinum.

21.66 parts of mercury have therefore been employed to precipitate 10.34 parts of platinum, and it requires twice as much mercury as platinum to saturate muriatic acid. If we suppose with M. Berzelius, that the mercury is oxidated in corrosive sublimate, we may conclude, that the platina in the common muriate, contains twice as much oxygen as of sulphur; but this experiment by no means proves, that there is oxygen in the muriate of platinum.

In comparing the quantities of sulphur and oxygen that may be combined with platinum, we find, that there is not the same proportion between them as between those two bodies and the other metals, for it appears, that in the soluble sulphates, the quantity of sulphur is twice that of the oxygen contained in the metallic base: this indicates, that there may be a sulphuret of platinum, in which the quantity of sulphur shall be twice, (or *sous double*) that of the oxygen; but we have not yet been able to obtain this compound.

It has been already remarked, that the quantity of mercury

necessary to precipitate the platinum, is rather more than twice that of the latter, even though a small quantity of sub-chloride of mercury remained, and was counted with the superabundant metal. To ascertain the quantity of this salt, it was treated with a solution of potash. The liquor, after being saturated with nitric acid, was mixed with solution of silver, and the precipitate formed, indicated about .05 parts of acid: thus there was rather more of mercury employed to precipitate the platinum than has been given above.

Experiment 11. If a solution of muriate of platinum, as neutral as possible, be mixed with a solution of nitrate of silver, so that there be a slight excess of the latter, an abundant yellow precipitate is formed, and the fluid entirely loses its colour. It appears, that in this experiment, the salts of silver and platinum mutually render each other insoluble: nevertheless, although the fluid be colourless, it deposits by evaporation, a small quantity of matter resembling that formed at the moment of mixture: the nitric acid which remains free in the fluid, does not hold any platinum in solution.

Experiment 12. Suspecting that in the precipitate formed by the mixed solutions of platinum and silver, the platinum had, by giving a part of its acid to the silver, become a sub-muriate, and was thus rendered insoluble, for nitric acid exerts no action on this salt, or even on the oxide of platinum, when dry, I boiled a certain quantity of it with solution of soda; at first there appeared to be no action, but after long ebullition, the substance became of an intense black colour: at the same time, if the submuriates of silver and of platina, be treated singly with caustic soda, they immediately become black, and the last of these salts is entirely decomposed; this appears to indicate, that there exists a combination of the two which resists for some time the action of the alkali, or that the platinum is not in the same state as in the sub-salt above described, for the black colour produced in the experiment, does not at all prove the decomposition of the salt of platinum, the chloride of silver taking the same colour when treated with caustic alkalies.

Experiment 13. Decomposition by heat, of the precipitate

obtained in the 11th experiment.—A certain quantity of the substance, which I supposed to be a mixture or combination of chloride of silver and sub-muriate of platinum, was distilled in a luted glass retort. In this experiment there was given out a great quantity of chlorine, which was recognised by its odour, its power of destroying the colour of litmus paper, and of precipitating nitrate of silver; the retort contained a fuzed substance, of a yellowish colour, at the bottom of which was some brilliant metallic platinum. There is therefore no doubt, according to this result, that the precipitate contained the platinum in the state of sub-muriate, for the chloride of silver does not give out chlorine by heat.

Experiment 14. Action of concentrated muriatic acid on the mixed precipitate of platinum and silver.—If, as we have just deduced from the preceding experiment, the precipitate really contains the platinum in the state of sub-muriate; this last ought to be dissolved with the assistance of heat in muriatic acid; this really happens—the muriate of silver becomes colourless, and the acid takes a yellowish red tint, at the same time less red than that which results from the direct solution of the sub-muriate of platinum in the same acid. It appears to resemble more the solution of common muriate of platinum, and in fact, does not deposit the sub-salt by evaporation, even though reduced to the consistence of a syrup: it is entirely converted into a yellow precipitate by salts of ammonia, without any mixture of the red salt, so that we are obliged to consider the solution the same as that of the common muriate, and allow a difference to exist between the sub-salt precipitated, by solution of silver, and that obtained directly by the action of heat on the common muriate.

Experiment 15. When the sub-muriate of platinum is acted on by caustic soda, we find that the whole of the metal is not precipitated; a portion still remains dissolved in the liquor, from which it may be separated, by saturating the alkali with nitric acid. This alkaline solution is colourless.

The oxide is obtained of a white colour, and very bulky; it becomes of a bluish gray colour when dried in the sun, and of a deep black if dried by heat.

Submitted to the action of heat, after having been dried, it gives out oxygen gas, losing 15 per cent. of its weight, and is reduced into metallic platinum.

Before being dried, it dissolves in nitric acid without colouring it, but when it has lost its water, and become black, it is no longer soluble in it.

I have observed, that the quantity of oxide of platinum that remains dissolved in the liquor, increases in proportion to the alkali, for in an experiment, where I employed but 6 parts of soda to decompose 10 parts of submuriate of platinum, I found, that there was much less oxide dissolved. It appears, therefore, that it is the excess of alkali that effects the solution, and that if no more alkali were employed than sufficient to saturate the acid, all the platinum would be precipitated. I have found, that the hydrated oxide of platinum dissolves immediately in soda.

It results therefore, evidently, that there is, as M. Berzelius has already stated, a hydrated oxide of platinum.

We have already seen, that the muriate of platinum, which has lost a portion of its acid, so as to become insoluble, is decomposed by soda potash, and, without doubt, by the other alkalies, and that it furnishes a black oxide, containing about 16 per cent. of oxygen.

If we endeavour to obtain, in the same way, the oxide of platinum from the common muriate, rendered as neutral as possible, and containing no useless acid, we do not succeed, the caustic alkalies, even in excess, forming no precipitate in this solution. The only difference in appearance is, that its colour becomes deeper and triple combinations are formed.

But why is not a similar combination, formed by the insoluble muriate, treated with soda? Is it because, in this last, the platinum exists, as M. Berzelius has said, in an inferior state of oxygenation? But even admitting this supposition, it does not explain all the phenomena observed.

The two chlorides of mercury, which we may reasonably suppose to have between them the same difference as the two muriates of platinum, are equally decomposed by the alkalies; but let us examine this question more minutely.

First, then, the oxide of platinum, which is obtained from the sub-muriate, by means of soda, contains between 15 and 16 per cent. of oxygen; and when we decompose the common muriate of platinum, by means of mercury, we find, that the platinum contained in it, is also combined with between 15 and 16 of oxygen, i. e. supposing the mercury in corrosive sublimate oxidated. This would announce, therefore, that the platinum is in the same state, both in the sub-muriate and the muriate, and that this last, during its conversion into the former, lost nothing but acid. If it be thus, we must admit, that these salts are chlorides, which, however, appears doubtful.

But on the other side, when the oxide of platinum, and the sub-muriate, are dissolved separately in muriatic acid, we obtain two combinations very different; the first, of a yellow colour, like that of the common muriate, may be evaporated to dryness, without undergoing decomposition, and gives, with sal ammoniac, a yellow salt, but little soluble. The solution of the subsalt, on the contrary, is of a reddish purple, deposits on evaporation, nearly all its salt in the same state as before solution, and mixed with sal ammoniac, gives but a very small quantity of the triple salt, but by evaporation, yields quadrangular prismatic crystals of a fine purple red colour: finally, the solution is precipitated as black oxide by potash, whilst the solution of the oxide is precipitated, as a triple salt by the same alkali. It sometimes happens, that the oxide of platinum contains a few particles of sub-muriate that have escaped decomposition; its solution then gives traces of black oxide by the alkali, and the red salt by muriate of ammonia; but the cause of this is evident.

If, in the third place, we observe, that the sub-muriate of platinum, formed by the mixture of nitrate of silver, and the common muriate of platinum, gives, on being dissolved in muriatic acid, a salt entirely resembling the common muriate of platina, we must conclude, that this salt, on precipitation, lost nothing but acid, since, in giving acid to it, it appears as before, which is not the case with the sub-muriate obtained by heat.

We have, thus, by experiment, found the same quantity of oxygen in the oxide of platinum, obtained from the sub-muriate, and in that of the common muriate. Again, we have found two sub-muriates, of which one becomes common muriate by the addition of acid, whilst the other, with the same acid, produces a new combination. The result of these experiments appear diametrically opposed to each other; nor can I draw any satisfactory conclusion concerning the different states in which the platinum is found in the two muriates.

In the mean time, if I may be permitted to hazard conjectures on this subject, I should say, after the preceding considerations, that it appears, that the muriates of platinum, are combinations of the oxides of the metal with muriatic acid.

When these muriates are heated, they disengage chlorine, but we do not know any true chloride which is decomposed by heat. In decomposing the dry submuriate, in an apparatus where the chlorine could be cooled as it was disengaged, it deposited a sensible quantity of water, a circumstance which would not happen if the salt were a true chloride. Hence it follows, that there should be two muriates containing the same oxide, but different quantities of acid, and two sub-muriates in which the platina is differently oxygenated. And lastly, that mercury does not afford a certain method of ascertaining the quantity of oxygen in the oxide of platinum contained in the common muriate; for I believe, that I am not deceived in the analysis of the oxide obtained from the sub-muriate, having repeated it a great number of times. The oxide of platinum contained in the common muriate, ought, therefore, to contain more than 15 per cent. of oxygen.

Art. IX. *Proceedings of the Academy of Sciences of the Royal Institute of France, from February to September* 1817.

We resume the account of the proceedings of this scientific body, where we left off, at the last meeting in February, (see Journal of Science, p. 179, Vol. III.)

March 3, 1817. After the minutes of the preceding meeting had been approved, the commission charged to examine the merits of the candidates for Lalande's medal, on the best work in astronomy, written or published in the course of the year, named Mons. Bessel as having deserved it, for his memoir on the comet of 1815. This gentleman, in the calculation he made of the elements of its orbit, has not neglected the perturbations which the comet must have experienced fróm the action of the other celestial bodies.

Mons. Humboldt read a memoir on the guacharo, a night bird, found in great plenty in the grotto of Caripe, situated between the Orinoco and the coasts of Cumana. This memoir has since been published in his great work on the natural history of South America.

The proposition made by Mons. Lucas, senior, for an improvement in the firelock of muskets, mentioned in Vol. III. has been rejected by the Duke de Raguse, who made a report on it in the name of the commission appointed for that purpose.

10*th March.* M. Lemonnier proposes to employ lime for producing brilliant colours in dyeing. A commission was named to examine his paper.

A paper by Mons. L'Abbé Manesse, deposited in the archives of the Academy of Sciences since 1786, was opened and read. It related to a physiological fact respecting generation. A memoir of Proust on bread made with musty flour, was laid on the table.

M. Humboldt read a memoir *on caverns of rocks, and on their relation to the strata in which they are found.* He examines the rocks in successson, and describes the grottos he had occasion to observe in the Andes, in transition, secondary, and volcanic rocks. He mentioned those immense openings found in the trap-prophyries of the Cordilleros, by the Peruvians called *Machays.* He is inclined to think them, from their configuration, formed by the sudden extrication of some elastic vapours.

A report was read by Brochant on M. Beudant's memoir on the relative importance of the crystalline forms in the scientific arrangements of mineralogy, of which we gave an account page 178, Vol. III.

General public and annual meeting of the Academy of Sciences.

M. Delambre read an essay on the history of astronomy.

Mons. Cuvier read his *Eloge de Mons. Tenon*, a surgeon.

M. Latreille read his Considerations on Insects, *(vivant en société)*. The prize medal founded by Lalande was given to Mons. Bessel, director of the Observatory at Koenigsberg.

The subjects for the prizes proposed by the Academy for the year 1818, on mechanical philosophy, are, 1st, to determine the comparative march of the mercurial and the air thermometer, from — 8° to + 200° centigrade. 2dly, The law of cooling in vacuo. 3d. The laws of cooling in the air, hydrogen, and carbonic acid gas at different degrees of temperature, and for different degrees of rarefaction. January is fixed as the term for receiving the memoirs, and the results to be published the first Monday in March following. The other prize questions were renewed, with few modifications, as they stood last year. Amongst them we remarked, that which relates to the effects of the diffraction of the luminous rays, direct or reflected, when they pass separately or simultaneously near the extremities of one or more bodies; and to ascertain, by an appropriate series of experiments, and mathematical inductions, the movement of the rays in their passage near the bodies. Our readers are perhaps aware that MM. Young, Arago, Fresnel, and others, have made this a subject of some of their most important inquiries. The prize to be given at a public meeting in May 1819, and to consist in a medal of 3000 francs value.

March 24. Minutes of the public annual meeting were read and approved. M. Majendie lays before the Academy the MS. of the second volume of his *Physiology*.

M. Dutrochet sends some calculations and reflections on the aérolite which fell at Charsonville.

A report on the *Emetine* found by MM. Pelletier and Majendie, of which we gave an account, was presented by MM. Thenard and Hallé. These gentlemen concluded with considering the memoir in question worthy of being inserted amongst the memoirs of the *Savans Etrangers* (the highest degree of approbation) and expressed a wish that every other compound remedy may

be thus analysed. "Thus chemistry would probably acquire new principles, and the healing art fresh remedies, to combat the numerous diseases with which mankind is afflicted."

Messrs. Desfontaines read a very ample report on a memoir of Mons. Desvaux, entitled :—*Dispositio methodica generum Lycopodiorum et Filicum.* There is not perhaps a more difficult branch of natural history than the study of the Cryptogamia. M. Desvaux has excelled in it for many years. He has described several new genera of the classes of plants mentioned in the title of his paper, of about one hundred and ten species of ferns never before published. Their characters are given with great accuracy, and are accompanied by drawings, by which their study is facilitated. The author has added several critical notes, on the description and synonymes of many well known ferns. He had presented a copy of his paper to the Linnæan Society, which they declined reading.

M. Dartigues read a report on a machine called, *le Balancier Hydraulique.* Referred to a committee.

M. Rigaud de l'Isle read a memoir on the *Aria cattiva,* in the environs of Rome. The conjectures respecting the mode of action of the miasmata on the human body in these cases, have been as desultory as they have been numerous. Nor have the means proposed to avoid their effects had better success. Mons. De L'Isle thinks he has ascertained that what constitutes the *malaria,* is the constant and regular series of emanations from decomposing animal and vegetable substances, on which the powerful sun of the preceding summer had been acting. That these invisible atoms spread and mix in the air with which they are drawn into the lungs; hence the best mode of preventing this would be to *sift* the air to be breathed, which might be done by wearing a fine silk gauze over the mouth and nostrils. The miasmata are heavier than the air, and are, therefore, always to be found in the lower strata. A very high place of residence in countries infected by malaria, would of course be a perfect security from its influence. The author had an opportunity of making some experiments near Rome, and at the Pontine marshes: he there found that an elevation of 300 yards was a complete security from infection. Watery vapours are, accord-

ing to him, the true vehicle of the miasmata; hence the bad effects of dews, fogs, &c. and the very curious circumstance that the middle of towns is often more salubrious than the suburbs. The pituitous membranes, and the adjacent parts, are considered by M. Dellile as the organs on which the miasmata first accumulate, till they have acquired sufficient power to infect the whole system.

31*st March*. M. Burckardt read a report on the new planetaries of M. Jambon. Mons. Portal read a paper on the aneurism of the heart, with and without thickening of its subsance. Adjourned.

April 7. Mons. Beauvoir states, that two fossil heads had been found at Philadelphia—the one resembling that of a stag; the other was of an unknown animal.

Mons. Delambre read a report on the translation of the Lilawati, from the Sanscrit of M. John Taylor. Bhascam is the author of the present treatise on arithmetic and geometry.

A continuation of Mons. Portal's paper on aneurisms of the heart, after which the meeting adjourned.

Meeting of the 14*th April*. MM. Pelletan and Percy read a report on a memoir of Mons. Maunoir of Geneva on the hydrocèle of the neck. This is the disease called by other nosologists *aqueous bronchocéle*. Mons. Maunoir recommends puncture in the first instance, and the subsequent application of several setons. By these means, he states having had complete success in the cure of this disease.

A report on Mons. Majendie's paper relative to the action of arteries, of which we gave an account in another part of our Journal, was read by Messrs. Biot and Percy.

We have also mentioned somewhere before, the paper of Mons. Fourrier on *grasseyement*, on which Mons. Dumeril now read a report.

An unfavourable report of Delambre, on the Opuscoli Matematici del Sacerdote Dionigio Soda, was read to the Academy. After which, Mons. Langier communicated his analysis of the meteoric stones of Siberia. Adjourned.

21*st April*. Mons. de Jonnés read some observations, physiological and others, on the influence of the hot and humid climate of the Antilles, on the different systems. Mons. Pelletan

communicated some further illustrations on the improvements made in the mode of lighting with carburetted hydrogene gas. Neither of these papers presented any material point of importance.

Mons. Roux, *chirurgien en second adjoint de la Charité,* read a paper on the operation for cataract. He recommends above all other methods that of extraction.

MM. Chevillot and Edwards read their memoir on the cameleon mineral. The authors have endeavoured to ascertain the composition of this body, and the theory of the singular phenomena it offers. The cameleon, every chemist knows, is a combination of manganese (peroxide) and caustic potash. When a solution of this compound in water is suffered to remain at rest, for some time it is seen to pass, from the green, (colour it first assumes), through the whole series of coloured rays to the red. From this latter tint it may be retrograded to the original green colour, by the addition of potash—and lastly, the solution may be rendered altogether colourless, by adding either sulphurous acid gas or chlorine to the solution, in which case there may or may not be a precipitate. This was observed by all chemists; but what had not been observed before, say MM. Chevillot and Edwards, is the composition of this body during the different stages in which it presents the different phenomena of colour. They employed the sulphate of manganese, and the black oxide of the same metal from the decomposition of the nitrate, and in both cases when combined with potash the green cameleon was produced. Having examined the precipitate formed by the spontaneous decomposition of the cameleon, and submitted it to the action of boiling sulphuric acid, they obtained pure sulphate of manganese; hence say they, the colouring matter of the cameleon depends upon the manganese. They also endeavoured to ascertain in what state of oxidation the metal was in the combination, and whether there was a real combination, without any other intermediate agent; whether the external air, for instance, influenced the phenomenon; and they found that when potash and the green oxide of manganese were heated in close vessels, containing azote, no cameleon is formed. The same result followed the experiment with brown oxide, and ultimately

with the peroxide. Hence it should seem, that the presence of air or oxygene is necessary to the formation of the cameleon; and that there must be an absorption of a fresh portion of that principal during the combination. This they proved by a direct experiment to be the real case; and further, they ascertained that the absorption of the oxygene is not due solely to the potash, as first observed by Gay Lussac and Thenard, but to both, and that it is greater when the quantity of the oxide of manganese is the largest—that is, equal to the quantity of potash. They have given a table of the quantities employed, and the oxygene absorbed.

Meeting of the 28th April. Mons. Chambon read some remarks on the gout; and the Academy resolved itself into a committee of scrutiny for the election of a member in the room of Mons. Rochon, deceased, and of Klaproth as foreign associate.

Monday, May the 5th. Minutes read and approved. Several books were presented. Mons. Poinsot read a Memoir entitled, *Extrait de quelques Recherches nouvelles sur l'Algebre et la Theorie des Nombres.*

MM. Arago, Ampère, and Cauchy read a report on a memoir of Mons. Dupin, corresponding member, respecting the "routes suivies par la lumière dans les phenomènes de la réflexion." The author has established the following principle. "When a bundle of luminous rays is reflected by any given surface, if the incident rays are all normal to one surface only, they preserve this same property after an indefinite number of reflections." The commission is of opinion that this new memoir of Mons. Dupin is deserving the highest approbation of the Academy.

A report was read by Thenard and Gay Lussac on the Memoir of MM. Edwards and Chevillot *sur le Cameleon mineral.* They approve the conclusions drawn by the authors from their experiments, at a repetition of which they had both assisted,

M. Deschamps read a report on a memoir of Baron Larrey relative to the amputation of the thigh at the hip joint.

The following candidates were presented by the Secret Committee, for the vacancy occasioned by the death of Mons. Rochon. MM. Fourier, Dulong, Petit, Thillaye, Fresnel, Pouillet, Tremeny.

12*th May*. M. Fourier was elected Member in the Section of Mechanical Philosophy.

M. Pelletan, junior, read a memoir on a new application of Dr. Wollaston's *Camera Lucida*, which was referred to a commission. M. Tessier read a note on the length of the period of gestation in different species of animals. The "*Remarques sur les trombes*" by Mons. de France, and the continuation of Roux's paper on the operation for cataract were next read; and the Academy adjourned.

19th May. Dr. Granville presents his account of the life and writings of Baron Guyton de Morveau, accompanied by a letter explaining the motives which made him undertake that task, and requesting that a copy might be distributed to each of the members of the Royal Academy. (see vol. iii: Journal of Science, p. 249.) Mons. Cuvier presented a memoir by Sir W. Adams, on restoring vision. Pelletan and Percy, Commissaries.

Mons. Portal read a memoir containing some considerations on vomiting. Dr. Majendie endeavoured sometime ago to shew, that the stomach in vomiting is nearly passive, and that the diaphragm and abdominal muscles are the only agents in that phenomenon. In some of his experiments, Dr. Majendie had even pushed the demonstration so far, as to substitute a bladder in place of the stomach, (which had been removed in a dog) when by exciting the action of the above named muscles, vomiting was produced; i. e. the ejection of the coloured liquid contained in the bladder. Dr. Portal now comes forward with other experiments to prove that Dr. Majendie's general assertion was too hasty—that vomiting begins by a particular action of the stomach, as commonly supposed by physiologists in general, and is further continued by the action of the abdominal muscles and diaphragm, but, that in many cases, the latter are by no means necessary, as he states having ascertained, that vomiting may be produced in the stomach, where the abdominal parietes have been removed, a fact which he had occasion to observe in an experiment made for that purpose.

Mons de Savigny presented a memoir on the *Aurellides*.

Mons. Maizieni read a notice on a new hydraulic machine suggested by witnessing a curious natural phenomenon which

takes place on the coasts of the Island of Teneriffe, where the waves penetrating a deep grotto situated on the sea shore, produce a jet of considerable height on the superincumbent terrace. A manufacturer of salt has profited by this natural jet to the great benefit of his establishment. A commission was charged to examine this paper.

The Section of Astronomy presented the following list of candidates for the vacant place by the death of Mons. Messier. MM. Mathieu, Puissant, Daussy. Adjourned.

26th May. A letter from the Minister of the Interior was read, transmitting the ordonnance of the King, approving the nomination of Mons. Fourrier in the room of Abbé Rochon deceased.

A letter was read from the perpetual Secretary of the Academy of Dijon, sending a problem relative to *Le jeu du Solitaire.* A committee composed of Arago and Ampère were charged to examine it.

Mons. Girard read a report on the *Balancier Hydraulique* of Mons. Dartigues. He concluded with saying that it is an important improvement, and that it deserves the approbation of the Academy.

Mons. de Humboldt begun reading his highly interesting memoir on the distribution of heat on the surface of the globe, which he arranges in bands called Lignes Isothermes. The Memoir has since been published in the third volume of the Transactions of the Societé d'Arcueil. Mr. Ritchie, attached to the British embassy at Paris, a scientific gentleman, has undertaken an English translation of this masterly performance. Adjourned.

2d June. A work from Sig. Buccellati on the putrid fever of Milan. The Journal de Pharmacie for 1817. The Elemens de Géometrie à trois dimensions, by Hachette, were severally presented to the Academy. They next proceeded to the election of a member in the Section of Astronomy, when Mons. Mathieu was unanimously chosen; his election will be submitted to the King for approbation.

Letters were read first from M. Bessel, thanking the Academy for the premium awarded to him (Lalande's Medal); secondly,

from a Professor at Stuttgardt asking for funds, in order that he may submit to the Academy the means of making bread without flour, and wine without grapes, and of rendering water more portable by a new process of crystallization to which he has submitted that fluid (laughter); thirdly, from General Alis, requesting the Academy to intercede with the Minister of Finance, that his work destined to overthrow the Newtonian system of attraction, may be admitted free of duty into France, for the edification of the learned.

De l'affection tuberculeuse dans certains animaux by Dupuis.

Strictures on the pretended discoveries of Spurzeim, by Dr. Gordon. (Cuvier named for a report.)

The Bibliothèque Universelle for March and April.

A solution of the problem "sur la Quadrature du Cercle," and

The Annals des Arts et Manufactures were severally presented by their authors.

Mons. Thenard read a report on Mons. Laugier's memoir, giving the Analysis of the meteoric iron of Siberia, in which he found chrome and sulphur.

Mons. Humboldt continued the reading of his paper on the Lignes Isothermes. Adjourned.

June 9. Minutes of the preceding meeting were read and approved. Mr. Higgins of Dublin presented a copy of his Experiments and Observations on the Atomic Theory in Chemistry. Gay Lussac was charged to make a verbal report.

A number of the *Journal d'Agriculture*,

Of the *Annales de Chimie* for April, and a number

Of *L'Israelite Français*, a periodical work on moral and literary subjects, were next presented to the Academy.

Mons. Fevre sends the first part of his MS. Essays on the formation of Chemical tables, presenting mathematical formulæ for every case of Chemical experiment, with a view of expressing their results in an algebraic form. The work was not of a nature to be read, and was therefore referred to a committee composed of MM. Gay Lussac, Poisson, and Thenard.

The Academy proceeded to the nomination of a Commission who is to present a list of Candidates for the vacant place among the Foreign Associates in the room of Klaproth deceased, MM.

Laplace, Legendre, Gay Lussac, Berthollet, Thenard, Hallé, were named for that purpose.

A report was next read on a work (MS.) of Mons. l'Abbé Manesse, entitled Oologie, or a treatise on the eggs and nests of various birds. There are 216 new species of birds and their eggs described in it, accompanied by beautiful drawings. The Author requests the Academy to apply to Government for the necessary funds for publishing it.

Humboldt continues his Memoir on the Lignes Isothermes.

A Mons. Repaut, member of the Institute of Ægypte, reads his observations on Hieroglyphics, and by an application of his notions on this subject, to the occult parts of scripture, pretends to have ascertained their real meaning. Adjourned.

16*th June.* The Academy received the following presents :

Bibliothèque economique for June.

Analyse de l'Eau de Mer, par M. Sage.

A letter was read from the Minister of the Interior, conveying the King's approbation of M. Mathieu's nomination as member in the Section of Astronomy. M. Mathieu was desired to take his seat. Another letter from the widow of Mons. Legallois, states, that having been left with a family in narrow circumstances, and understanding that there exists a fund at the Institute for the remuneration of authors who have made any important researches, requests that a portion may be applied to her relief, in consideration of her late husband's important inquiries. (To be taken into consideration.)

A German gentleman, whose name we could not distinctly hear, presented some volumes of a work on hydraulic architecture.

Mons. Pinel read a report on the memoir of Mons. Esquirol, on Hallucinations. The reporter, after observing that all classifications in regard to mental derangements are arbitrary, and after severely animadverting on Dr. Crichton's division of those diseases, states it as his opinion, that M. Esquirol has succeeded in defining and circumscribing in a neat and very exact manner the kind of mental *vesania* called Hallucinations, of which he had occasion to witness several cases at the Salpetrière. A description of the disease, marking the external signs peculiar to

it, the progress and changes it is subject to, and the ultimate issue, was given in an appropriate manner. In one case in particular, where the patient was affected with demonomania, and died, the dissection *post mortem* shewed a complete and general disease of all the viscera. The reporter concludes from all the preceding information, that there is a kind of alienation to which the mind of man is subject, called *hallucination*, attacking and running on like an acute disease, being primitive and secondary—having an origin—progress—and decline—and capable of being cured. It becomes at times epidemic, and is gained by communication where a defective insulation exists in the establishment. In such cases the disorder resists all remedies. This disease, which affects principally the thinking faculty, and gives a particular character to the individual attacked by it, should never become the subject of criminal jurisdiction before the tribunals—but be always left for medical treatment and interference. Thus we have seen persons, said Pinel, in whom political events called forth the most strange conceptions on some of the clearest matters of fact; and others whose mind religious enthusiasm rendered incapable to appreciate the difference between the marvellous phenomena which nature often presents to us, and the mere effects of superstition. The history of our times furnishes us with as many examples of the former, as the *histoire des Saints* supplies us with many of the latter kind of hallucination. On the President proposing the adoption of the conclusions of the Reporter, Mons. Cauchy, a young man lately named member of the Institute, called the attention of the Academy to the impropriety of adhering to the Reporter's proposition. *Que deviendraient-ils*, exclaimed he in a voice rendered faltering and agitated by religious zeal, *tous ces miracles dont nous lisons les pieux détails dans tant d'ouvrages religieux; et surtout les hommes saints qui en ont été la cause, et qui les ont multipliés pour nôtre instruction? Je tremble en y songeant seulement! Les appellera-t-on des hallucinations, et des hallucinés?*—The Academy however rejected the amendment, and the original proposition was carried nem. con. The interesting memoir we allude to, forms one of the Articles inserted

in the last volume of the Dictionnaire des Sciences Medicales, Tom. XX.

Mons. Humboldt, after presenting the last livraisons of his Equinoxial plants, continued the reading of his paper on the *Lignes Isothermes.*

Mons. Girard begins reading his memoir, *sur la vallée du Nil, et l'exhaussement seculaire qu'elle a subi.*

Mons. Laplace presents the list of candidates for the vacant place of foreign associate. These are MM. Scarpa, Davy, Piazzi, Gauss, Wollaston, Jacquin, et Leopold Von Buch.

June 23d. A letter was read from the Secretary of the Stockholm Academy, sending a continuation of the memoirs of that Society.

The 3d Volume of the Transactions of Arcueil, and a continuation of the Memoirs of the central Royal Society of Agriculture were likewise presented.

Mons. Dupin, corresponding member, submits to the judgment of the Academy a MS. volume, giving an account of a journey in England, and of the progress of artillery in that country. The Duke de Raguse and M. Prony appointed Commissaries. The work of Governor Raffles on Java, was presented by Mess. Barbié du Bocage and Langlés.

Mons. Humboldt presented *un tableau physique* of the Canary Islands, with the geography of the plants of the Peak of Teneriffe, represented on a profile of this mountain, from the observations of Mons. de Buet. Also maps of the Volcano of Jorullo, of Rio Cauva and the Cordilieros of Santa-Fè and Rio-Meta.

Mons. Girard contiñues reading his memoir on the *Exhaussement de la Vallée du Nil.*

M. Geoffroy-Saint-Hilaire begins his paper entitled, du Squelette des poissons ramené dans toutes ses parties, à la charpente osseuse des autres animaux vertebres.

The Academy continues, in a secret committee, the discussion on the relative merits of the Candidates for the place of Foreign Associate.

M. Gay-Lussac made a verbal report on morphine, and re-

lated a new method employed by Mons. Robiquet to obtain that substance from opium, as well as the meconic acid.

30th June. A letter was read from Count Dandolo, sending two new works. *Della Coltivazione dei Pomi di Terra*—and *Storia dei Bacchi di Seta.*

A Letter from the Minister of the Interior announces that in the Archives of that office, he found a volume of the Transactions of the Royal Society of London for 1811, addressed to the Institute, and which had been, it appears, detained at that epoch, by the minister then in office.

A Mons. Bourdilleau sends a new instrument called *Trizonometre*, to be examined.

The *Bibliothèque Universelle* for May,

The *Annales de Chimie* for ditto, and

The VIth part of *Legendre's Exercices de Calcul intégral,* were severally presented by their authors.

Mons. Arago presented, in the name of Monsieur Reboul, corresponding member, a Memoir *sur le nivellement des principaux sommets des Pyrenées.*

The Academy proceeds to the election of a Foreign Associate. Scarpa was elected.

Mons. Geoffrey continues the reading of his memoir.

Mons. Humboldt read a memoir on the basis of his map of the course of the river Oronoco, and its bifurcation.

Mons. Cauchy read a paper on the *reciprocal functions.* Adjourned.

7th July. A memoir under seal, is sent by the author, requesting that it may be registered and deposited in the Archives of the Academy. The memoir is suspected to relate to the physical mode of instructing the deaf and dumb.

A prospectus for a subscription to a collection of medals of the Royal Family was circulated, and the Author doubts not, in his letter, but that the members will hasten to avail themselves of the present opportunity of showing their loyalty and attachment to the best of sovereigns.

The Annales de Mathematique, and the Journal de Pharmacie for June, were presented.

Mons. Gautiez sent a work entitled "*Essai historique sur le*

Problème de trois Corps, et le Mouvement de la Lune. Poisson to examine it.

Mons. Destruches presents a comparative table of the vessels of war, French and English.

Mons. Rossel read an extract of a letter from Sir Joseph Banks, giving an account of the damage caused by a late tempest on the south coast of Britain.

Mons. Girard continues the reading of his paper on the Valley of Egypt, and the secular elevation of the soil which covers it. The memoir is divided into five sections. The first contains a description of the valley of Egypt in its actual state, and of the annual variations of the Nile—the second relates to the volume of the waters of the Nile, to the transverse levellings of the valley, to the soundings of the soil—the third is consecrated to the knowledge and opinions of the Ancients respecting the soil of Egypt and its formation, observations of the Moderns, and discussions arising on this subject. In the fourth we find some enquiries and observations made with a view to determine the quantity of the secular elevation of the bed of the Nile and the soil of Egypt; and lastly, the fifth section presents us with an account of the different causes, the continued action of which modify the aspect of the valley of Egypt, and of the changes it may yet undergo. Mons. Regnault has added an appendix, in which is found the following analysis of 100 parts of the *limon* du Nil, dried in the sun: 11 water, 9 carbon, 6 oxide of iron, 4 silex, 4 carb. of magnesia, 18 carb. of lime, 48 alumine.

11*th July.* A letter from Mons. Barbançon, on electricity, was presented, as well as a systematic table of the *annelides,* by Savigny, part 2d.

Several memoirs on important subjects are transmitted for examination by the Minister of the Interior.

Mons. Humboldt presents the second part of his 2d volume of the personal narrative of his voyage, and a map of the river Oronoco, and of that of the Amazons.

The *Annales Maritimes* ,and No. I. and II. of the *Jurisconsulte François,* were presented.

A memoir to supply the deficiency of the Newtonian system,

by a Mons. Lambert, of the United States, was referred to a committee.

An Italian botanical work, in five volumes, was presented from the author, and the mathematical part of the memoirs of the Italian Society.

Donovan's History of Galvanism was referred to Gay Lussac for an opinion.

Dr. Edwards read a memoir *sur l'Asphyxie dans les Batrociens.* The author has obtained the most extraordinary effects by treating several frogs, toads, and salamanders, with submersion, suffocation, and strangulation. Some kept in quite dry air, died immediately. Others, on the contrary, lived many days immured in thick coatings of plaster of Paris—while others again gave signs of life even 15 days after having been strangled and decapitated; living indeed long enough for a complete cicatrization to take place, of the wound occasioned by decapitation. Messrs. Thenard and Dumeril were named to examine this paper.

21st July. The confirmation of Scarpa to be a Foreign Associate, was transmitted by the King through the minister of the interior.

Mons. Moreau de Jonnés read a memoir on the *Araignée aviculaire des Antilles.*

A report was read on a work presented in MS. by Mons. de Ferussac, entitled, *Histoire générale et particulière de Mollusques terrestres et fluviatiles.*

M. Tomard read a dissertation on the measures of the ancient Egyptians.

28th July. General Sauviac sends several memoirs on the blue saphirs. Referred to a commission.

An unknown person proposes to found a prize, value 3000 francs, for the best and simplest machine calculated to extract the most and the best quality of matter fit for spinning from hemp and flax. A committee was appointed to take the proposition into consideration.

M. Thenard read a report on the memoir of Mons. Robiquet on the best mode of obtaining morphine and the meconic acid.

Mons. Hugard read a paper on English horses and horse-racing.

Mons. Clocquet, junior, sends a copy of his thesis on the anatomy of the abdomen and on hernia.

Mons. Ranson sends a memoir on the rectification of the mathematical value of the sphere. Cauchy named for a verbal report.

A continuation of the Annales des Mines was presented; and the XVIII. Vol. of the Italian Society.

A letter was read from Biot, sending a detailed account of the expedition of which he forms a part. In it he praises much the hospitality and the *empressement* of Mons. Pond, Mudge, and others, to do every thing that can be agreeable and of service to him.

4th of August. Minutes read and approved.

A number of the Journal de Pharmacie was presented.

M. Sylvestre read a report on the proposition made by the unknown person respecting flax. He entered into several details, and lastly mentioned, that, by a very curious coincidence, Mons. Chretien, of the Conservatoire des Arts et Métiers, had just invented a machine completely answering the description of that which the unknown person desires, and that Mons. Chretien will, with the permission of the Academy, present the said machine for their inspection at the ensuing meeting. Approved.

Mons. Laplace read a note on a new application of his calculus of probabilities to geodesical operations. It consists in drawing the most probable results from a great number of observations, and in rectifying the errors by means of a formula, which he gives in his paper on this subject.

The memoir of Mons. Meziere, on the natural phenomenon observed on the coasts of the island of Teneriffe, mentioned in another part of this account, formed the subject of a report by Mons. Girard. This gentleman compared the phenomenon to what takes place in what is called the Fountain of Heron.

Mons. Cauchy said a few words of disapprobation of Mons. Ranson's paper, presented last meeting.

Mons. Latreille read a memoir on the linear measures of the ancients, which he refers in *ultimo loco* to the human foot, for

every nation; it is most probable, says the author, that the ancients felt the necessity of having a fixed linear measure, long before they could have become sufficiently instructed in astronomy or geometry, for establishing a system founded on those two sciences, as many modern writers would wish us to believe in their very learned dissertations.

Mons. Menard de la Groye read a memoir on the air volcanoes of the Modenese. We have nothing to say on this paper.

11th August. A statistical account of Portugal down to 1816, was presented by Mons. La Serda, with map. The *Annales Mathematiques et Bulletin des Sciences Medicales* were likewise presented.

Mons. Thillosier communicates a fact which induces him to think that the squirrel, besides that of jumping, possesses likewise the gift of flying. The author had been making some experiments on a favourite animal of this kind, and finding him one morning in a place far distant from where he left him at night, he *naturally* concluded that it must have flown thither.

15th of August. The following are the candidates, amongst whom the foreign member, in the room of the late Mons. Werner, is to be selected. MM. Davy, Piazzi, Gauss, Wollaston, Jacquin, Von Buch, Brown. The election proceeded, when, after the first scrutiny, M. Piazzi was found to have the majority of votes.

Mons. Orfila presented a copy of his work on medical chemistry. Mons. Longchamps presented his *Voyage dans le Jardin de Flora.* After which, Mons. Geoffroy continued the reading of his memoir on the skeleton of fishes.

26th of August. A letter was read from Mr. Farey, accompanying a copy of his work on the agriculture and mineralogy of Derbyshire. MM. Brochant and Ivast were named commissaries for a report.

The Annales de Chimie for July—the Bibliothèque Universelle for June and July—and a Journal of the Academy of Natural Science at Philadelphia, were presented.

General Sauviac sent four other memoirs on the manufacture of precious stones.

Mons. Palisot de Beauvois presented the 9th livraison of the insects of Africa.

Mons. Puissant presented extracts from the MS. of his second edition of the great work on geodesy.

Dumeril read a report on Dr. Edwards's memoir on the "*Asphyxie considerée dans les Batraciens.*" The commissaries approve it much, and engage the author to continue his inquiries on so important a subject. The same gentleman made a verbal report on Mons. Cloquet's memoir on inguinal herniæ.

Latreille read a report on the insect sent from America to the Academy, through the Minister of the Interior. He found it to be a Cicada septemdecis. Adjourned.

Art. X. *An Essay on the Variations of the Compass, shewing how far it is influenced by a change in the direction of the ship's head, &c. &c. By* William Bain, *Master, Royal Navy. Edinburgh.* 1 *vol.* 8*vo. pp.* 140. 1817.

Although the attraction of the magnet and many of its leading properties, have been noticed, and admired from the remotest antiquity, yet little or nothing is known of the causes of its action, and how these may be influenced by particular circumstances. The importance of the directive influence of the magnet is however great beyond measure, particularly to a maritime nation, and if the various hypotheses and theories which have been formed by some of the most eminent philosophers, have failed to account for magnetic effects, or in reducing them to that system and order so essential to the perfection of any science, that failure must be attributed rather to the want of a sufficient number of well authenticated facts, upon which they could ground their reasoning, than to any defect or want of due consideration of the subject.

The magnetic influence has long been known to have a variation, which is constantly changing; but that change is so slow and at the same time so different in various parts of the

world, that it would be in vain to seek for the means of reducing it to established rules, until all its local and particular circumstances are clearly ascertained and recorded by accurate observations made in various parts of the globe. The necessity and importance of such observations are now pretty generally understood, and they have actually been carrying on for some years past; but these remain to be collected, collated, proved, and afterwards brought together into one focus before even a foundation can be formed upon which any thing like a sound and stable theory can be constituted for the explanation of such changes.

Much, therefore, remains to be done in magnetism before its influence can be understood; and considering its important use in navigation, it is really astonishing that so little attempt at progress should have been made in its investigation. Although its power of attraction seems to have been known in the earliest antiquity, yet its directive influence or power of pointing in a meridian or N and S, does not appear to have been discovered till the 13th century, when we are told it was first applied to the purposes of navigation in the Mediterranean sea. Nearly two centuries after this period, Columbus in his voyage to America in 1492, discovered that it was deceptive, or did not always point N and S, and about 1625, Professor Gillibrand of Gresham College, ascertained that this variation was itself subject to change. The developement of these new and extraordinary facts, produced a lively interest among men of science throughout Europe, until the middle of the last century, and the exertions of our justly celebrated and indefatigable countryman, Dr. Halley, as well as the encouragement which he received from the British government in forwarding his views, can never be forgotten, though his labours were unsuccessful.

When a man like Halley had been foiled in his attempts, it cannot be matter of surprise that succeeding philosophers should have been shy of attempting that which his luminous mind could not effect, and accordingly since his time we meet with little in this branch of philosophical enquiry which has thrown light upon the subject; indeed it has sunk almost into oblivion.

No difficulties, however great, should obstruct the paths of

Science, and as we earnestly look forward to this branch of knowledge being one day or other resumed with redoubled ardour, we rest assured that any attempt to pave the way to such investigations must be acceptable to the public, and as the little work now before us contains observations upon phenomena which exist in the magnetic system, and which appear to be of the utmost consequence to navigation, we shall briefly analyse the five sections into which the author has thought right to divide his book.

The first section contains a concise, and we think a very accurate, view of the changes to which the magnetic needle has been subjected, since the middle of the 16th century, throughout the most conspicuous parts of the world. The authorities of these are given, and from them the mean annual change at London, during a term of 213 years, appears to have been about 10′ 4″; at Paris, in 254 years, 7′ 10″: at Dublin, in 134 years, 12′ 10″; at the Cape of Good Hope, in 191 years, 9′ 15″; at St. Helena, in 194 years, 7′ 52″; at Cape Comorin, in 137 years, 6′ 17″; at Cape Horn, in 112 years, the variation has neither increased nor diminished: it is about 23° east. It appears that on the coasts of Chili, Peru, Mexico, and the whole of the Caribbian sea, on the west; New Holland, Coast of China, Tartary, Japan, Kamtschatka, and all the great Asian Archipelago, on the east; the magnetic needle seldom deviates more than 3° or 4° from the true meridian. The coasts on which the greatest variation has been observed are, Cape Farewell, Davis Straits, Hudson's Straits, and Baffin's Bay; Mr. Bain says he has observed, between Cape Farewell and Labrador, 42° and 50°; and other navigators have observed, in Baffin's Bay, 57°. But what appears most astonishing is, that in East Greenland, about the parallel of Spitzbergen, the variation does not much exceed one point, and intirely ceases a little to the eastward of that Island. Captain Cook found the variation in 59° south lat. and 143 east long. 43° 45′ east, the greatest ever observed in the southern hemisphere; and in Bhiring's straits he found 35° 37′ east, variation.

Mr. Bain has inserted the greatest part of Dodson's tables of variation collected for the year 1757, as published in the

Philosophical Transactions for that year, with a view of drawing the attention of navigators to observe the change that may have taken place, when their course lies that way, since the above period, and many new observations are added; the result of such a proceeding, we should hope, might be extremely beneficial.

In the second section, the Author has, though we think in rather a confused and laborious manner, ascertained what he calls "the curves of no variation," that is, the lines separating the variation of an easterly from that of a westerly denomination, in both hemispheres. But though he adduces some curious facts in support of his reasonings, this part of the book is not of much utility to the navigator, and we shall, therefore, only notice that in the northern hemisphere, the westerly variation extends over a space of 200° 44′; and in the southern hemisphere, in the same parallel of latitude, 143° 10′; and the other, an easterly variation in the northern hemisphere over a space of 159° 16′; and in the southern of 216° 50′; and that the movement of the curve of no variation, which passed cape Agulhas in 1600 north-westward, has been nearly 26½′ annually. The curve which passed through London in 1662, eastward, Mr. Bain supposes lost among the smaller magnetic powers at present found in the continent of Europe and Asia.

The phenomenon of the magnetic dip, or inclination of the needle, which occupy the third section, was first discovered by Norman in 1592. To render this law in magnetism subservient to science and navigation, thereby benefiting mankind by the discovery, was then an object of much speculation and inquiry. Numerous theories were formed to account for such a wonderful phenomenon, and the latitude, on any meridian, was attempted to be discovered by its results; experience, however, very soon indicated its demonstrations extremely erroneous; and it has since been adverted to more as a matter of curiosity to philosophers than of real utility to navigators. Captain Flinders, in his last voyage of discovery, and M. Humboldt, in his valuable philosophical researches in the new world, have, independently however, enlarged our knowledge by some valuable remarks respecting

the dipping needle, and have, in some measure, rendered its results of considerable importance to the navigator. The former, at an early period of his voyage, observed, that the indications of the dipping needle had a close connection with the change, occasioned by the local attraction of the ship, in the variation of the compass; and that, as the north or south end of the compass needle was affected, so, in like manner, were the results of the dipping needle increased or diminished; this affinity he considered as occasioned by the magnetism of the earth, and the attraction forward in the ship, acting upon the needle in the nature of a compound force; for when the north end of the needle had dipped, it was the north end of the compass needle which was attracted by the iron work in the ship; and that the errors produced by this combined attraction, were proportionate to the *sines* of the *angles* between the ship's head and the magnetic meridian. On the magnetic equator, where the dipping needle stands horizontally, or there is no dip, there seemed to be no local attraction; but after passing some distance into the southern hemisphere, when the south end of the needle had dipped, observations again showed errors in the compass needle, but they were of a contrary nature to those experienced in the northern hemisphere, which evidently proved that the south end of the compass needle was now attracted. The importance of this discovery, deduced from many observations during the voyage, and verified, after his return, by a series of observations made on board five different ships at Sheerness and Portsmouth, made him conclude that the *error produced at any direction of the ship's head, would be to the error at east or west, at the same dip, as the sine of the angle between the ship's head and the magnetic meridian was to the sine of eight points*, or radius. But as this subject will occupy our attention whilst considering the next section, we must confine our remarks, to that part of the work; and here, we are sorry we cannot at present enter upon the excellent and valuable remarks made by the celebrated Humboldt, on the same instrument; but earnestly recommend them to the notice and attention of those busied in the investigation of the phenomena of terrestrial magnetism.

"There have been no navigators of celebrity," says Mr. Bain in his fourth section, "who, during their respective voyages, do not frequently allude to great irregularities found in the variation of the compass; but it was long concluded these irregularities arose from the imperfect formation of the *azimuth compass*, and not from any general or permanent cause. Dampier, Wales, Cook, Phipps, Beaupre, Vancouver, and other celebrated navigators, often mention them; but, it appears, it was left to the acute genius of Flinders, to explain the true cause which produced these discordances; which, together with the numerous observations made by our author, render the fact incontrovertible, that a variation will be observed on every point of the compass towards which the ship's head may be directed—a fact of much importance to navigation, and consequently to the general interests of the British nation." Our author then proceeds to illustrate the dangerous consequences to which navigators are liable from a non-attendance to this error in their calculations. From the observations above alluded to, it appears, that in the English Channel, North Sea, and Atlantic Ocean, where the variation is estimated at 27° or 28°, only 22° or 23° will be found with the ship's head at *east*; and 32° or 33°, when it is at *west*; thus making a difference of 5° on the course, without the knowledge of the navigator, which must necessarily produce corresponding effects on his dead reckoning. An instance of this is given in supposing a ship, bound down channel, at dark, St. Catherine's Point bearing north three or four miles, with the wind E.N.E.: she steers W. by N. during the night, and at day break next morning, the Start is observed bearing north three or four miles distance. Let it further be supposed, that at this instant the wind suddenly shifts to the W. S. W. and begins to blow hard, with thick rainy weather, which determines the captain to bear up for St. Helen's. As a W. by N. course carried him off the Start, he would naturally resolve to steer the opposite course up, namely, E. by S. On his supposed approach to the Isle of Wight, he is extremely anxious to see the land, and the weather continuing thick, he does not like to alter his course, being satisfied the one he is steering will take him near enough to shore. But after the distance is nearly run, no land is to be

seen; and as, perhaps, it is flood, he immediately hauls in shore, but it is too late; for being 15 miles to the south, and six miles to the east of his reckoning, he finds himself, by the time he sees the land, to eastward of Dunnose; and the gale continuing, he cannot possibly fetch his port. This fictitious case is often realised, and all navigators are aware of the consequences." But the following, among other tables which are given, will illustrate this case more clearly.

Table shewing the error in the reckoning between St. Catherine's Point and the Start, and the Start and St. Catherine's Point, by steering opposite points of the compass. Page 81.

	Course.	Dist.	Diff. Lat.	Diff. Long
Course steered down, by compass	W. 11° 15′ N.			
True variation, with head W. by N.	33. 0			
True course corrected for variation	S. 21.45 S.	90′	33′ 7″	83′ 4″
Course steered up, by compass	E. 11.15 S.			
True variation, with head E. by S.	23. 0			
True course corrected for variation	E. 11.45 N.	90	18.7	88.0
Error S. E. of the reckoning, by steering opposite points 90 miles			15.0	4.6

On examining the variation found in the German Ocean, our author supposes it does not exceed 25°; and being anxious to establish this point, we find, page 102, that he made some hundred of observations at different stations in the vicinity of Edinburgh, the mean of which gave 27° 42½′, which he considers too much, occasioned, in his opinion, by local causes at the different places of observation; but although the actual variation may not be quite so much in the North Sea, as that found in the English Channel, and at Edinburgh; the error in a ship's reckoning, produced by the change of the variation depending on the change of the course, is nevertheless nearly the same; and to put this point beyond a doubt, we again find that Mr. Bain had an azimuth compass made for the express purpose of

ascertaining the fact, by experimental observations made on board his Majesty's ship Ramillies, then lying in Leith Roads. A ship from Leith to the Naze of Norway, will, therefore, have an error in her reckoning of 27 miles to the south, and 18 miles to the east of that by account; and the same error in the reckoning will equally hold good, were she returning from the Naze to Leith. When our author was in the Greenland seas in 18° 14′, he appears to have paid very particular attention to this subject; accordingly we find him detecting an error in the reckoning, occasioned by the above-mentioned causes, of 4°. in the run to the North Cape; and 6°. in the run from the ice to Shetland, as is clearly delineated on a well executed chart prefixed to the work. And here we cannot but think highly of his zeal and professional talent, for the very ingenious, plain, and accurate method taken in the delineation of the variation, which is, undoubtedly, an original idea.

In the river St. Lawrence and its vicinity, our author experienced the same errors as before alluded to. "On coming down that grand and magnificent river, May 1813," he continues, "I found that it was necessary to steer a very different course from the opposite one made use of in going up, under very similar circumstances, a few days before. I noted this circumstance in my *Remark Book*, sent to the Lords of the Admiralty, on returning to England. And owing to that circumstance, and not having a copy of it, nor log-book to refer to, I cannot state, from memory, the courses steered; though I remember the difference to have exceeded one point; and we had an eight and nine knot breeze, both in going up and coming down, with the weather uncommonly fine, and every circumstance extremely favourable for making such remarks."

Should this publication ever come to a second edition, which we have no doubt of, we recommend Mr. Bain making application for these remarks, which appear to us extremely valuable; which, we are certain, will not be withheld.

" A ship from St. John's, Newfoundland, or from the southern part of the banks of Newfoundland, bound to England, by not making allowance for the change of variation,

will, by the time she reaches the Lizard, have an error of 64 miles in the latitude, and 198 miles in the longitude; that is, the ship will be all this difference to the E. S. E. of the reckoning; and the same error will be experienced going from the Lizard to St. John's, by neglecting the allowance to be made in the variation; and would just be the same, were it possible for the ship to run the distance in ten hours, instead of ten days," p. 92. In adverting to the currents in the Atlantic, our author thinks they are by no means so strong as generally imagined, and very ingeniously accounts for this mistake, so perplexing to navigators, by neglecting the allowance to be made, according to the course, in the variation; for it appears, that this error, if not attended to, will always place the ship to the south-east of her reckoning; consequently the greater the run, during the twenty-four hours, the greater will be the supposed current to the south-east. The following are his sentiments: "Notwithstanding these facts, I know it will be extremely difficult to convince navigators in general of the fallacy of their opinions respecting currents constantly setting with great velocity to the south-east in the Atlantic Ocean; and perhaps I may be scouted for the singularity of my conclusions. But, I presume, that one single fact established by experience, is stronger, and deserving of more credit than all the hypotheses, founded on theory, that can be brought together. I do not, however, deny the existence of currents in the Atlantic. Such an opinion would be perfectly absurd. But experience has taught me they are not nearly so powerful as generally imagined. While cruizing in the Atlantic, I have proved this by many experiments; and cannot help acknowledging, that I have found them apparently setting as often the one way as the other. But this is not generally the case near the land. Local situations produce local currents; and there are few capes or promontories where currents are not more or less experienced. But if those capes or promontories are situated within the influence of *monsoon* or *trade winds*, the direction of the waters follows that of the winds. These currents are, however, very superficial; and we frequently observe two

different currents in the same place, the upper part of the cable of a ship at anchor being sometimes carried one way, whilst the lower part is carried another. Even on the shores of the Florida Channel, the most remarkable in the world for its currents, a ship may pass the opposite way by the revulsion of the water close in shore." But we must refer the reader to what remains of this subject, as well as his criticism on "Humboldt's View of the Currents in the Atlantic," and conclude this article with what remains for us to notice.

It appears that Mr. Bain never had an opportunity of making any experiments of the kind above stated on board merchant vessels; although he thinks it extremely probable that a change of the variation, to a certain extent, will take place in them also; and this change will, in all probability, be much influenced by the nature of the cargo. "A ship of 120 guns," he says, "will have more attraction than one of 74 guns, this more than a frigate, and a frigate more than a sloop of war, and a sloop of war more than an empty merchant vessel. All ships of war have, besides their guns, a proportionate share of pig-iron ballast, which, no doubt, contributes, jointly with the iron-work in the ship, to produce a greater or less amount of local magnetic attraction. The generality of merchant ships having neither guns nor pig-iron ballast, he imagines cannot, therefore, have so much local attraction as ships of war. But the case may be greatly reversed when loaded with iron, and perhaps, other cargoes in mass." This we are inclined to believe is the case, and therefore do not hesitate in conceiving that a ship loaded with iron, will exert a very considerable power of attraction over the magnetic needle; and although, properly speaking, the magnet attracts only iron, in whatever state that may be, still there are few bodies which constitute the cargoes of ships which have not considerable portions of iron about them, or contain ferruginous substances capable of attraction. The list of these bodies is very comprehensive, and will, we have no doubt, when in such quantities as a ship's cargo consists of, exert a considerable magnetic influence over the compass

needle. Besides iron, and the ores of iron, the magnet is influenced by several other substances which contain that metal, and even also by some bodies which contain no iron whatever.

The last section is chiefly occupied in the investigation of the principles on which Captain Flinders established a rule for finding, with the indications of the *dip*, the true variation when observed at the binnacle. Mr. Bain, it appears, does not, however, put much confidence in the accuracy of the results given by this instrument; but as it is seldom used at sea, except on occasions of particular importance, which, perhaps, our author never had a concern in, we question whether Captain Flinders, who must have been intimately acquainted with all its properties, was not better qualified to judge on this point than our author; but however that may be, it is certain, that until a greater series of observations shall be made, this point must remain undecided.

The passages we have quoted will serve to shew how accurately our author has gone into this subject, and how well he is acquainted with the task he has undertaken. The book contains many excellent remarks and observations which our limits will not allow us to enter upon, and we must therefore conclude with recommending the work itself to the serious attention of every one connected with the shipping interest; whose thanks Mr. Bain deserves, for the zeal, assiduity, and professional ability, which are manifested, for the improvement of navigation, throughout his book.

Art. XI. *On the Difference between the optical Properties of Arragonite and calcareous Spar. By* David Brewster, *LL.D. F. R. S. Lond. and Edin. &c. &c.*

The interest which has lately been excited among chemists and mineralogists respecting the chemical composition of

Arragonite, will, I trust, be considered as a sufficient apology for communicating any new information regarding the physical properties of this extraordinary mineral.

In the examination of the optical structure of crystallised bodies, with which I have been occupied for more than two years, and the result of which will soon be laid before the public, I was particularly anxious to obtain proper specimens of Arragonite, in order to compare its polarising structure with that of Calcareous spar, which has only one axis of extraordinary refraction. In a specimen which I brought from Paris in 1814, the crystal was in many places intersected by thin veins, which produced the reduplication of images that has been so often observed in calcareous spar; but by covering these veins with China ink, I succeeded in discovering that *arragonite possesses two distinct axes of extraordinary refraction, one of which is parallel, and the other perpendicular to the axis of the hexaedral prism.* In another and more perfect crystal, with which I was favoured by Robert Ferguson, Esq. of Raith, I found that the two axes were distinctly exhibited, and that they had the same position and the same relative intensity as in the first specimen.

This structure is so different from that of calcareous spar, which has only one apparent axis of double refraction; and the results are so directly opposite to those obtained by Malus, and more recently by Biot in their experiments upon arragonite, that I was at first led to believe that the specimens which I had used were anhydrite, or some other mineral. I was soon satisfied, however, that this was not the case, by submitting them to the most eminent mineralogists of this country, as well as to some distinguished foreign mineralogists, who happened to be in Edinburgh. In one of the specimens indeed, the mensuration of the angles of the hexaedral prism, which I found to be 116° and 128°, put it beyond a doubt that I had been working with the real arragonite.

Those who have studied the *Théorie de la Double Refraction* of Malus,* and the researches of M. Biot on polarisation,

* See this work, p. 250, par. 3d and 4th, and p. 251.

which have lately appeared in his *Traité de Physique,** will find it difficult to understand how these eminent philosophers should have asserted so positively that Arragonite has only one axis of double refraction. I shall soon have occasion, in another place, to point out the cause of this mistake, which has had an extensive influence over many of the results obtained by these distinguished authors.

It would be interesting to examine if those specimens of Arragonite, which contain no carbonate of strontian, differ in any respect in their optical structure from those which contain the greatest quantity. It is highly probable that there will be no difference, but the experiment deserves to be tried by those who have the command of such specimens as are necessary for this purpose.

Venlaw, July 30, 1817.

ART. XII. *Experiments on sulphuric Acid, to determine the Law of Progression, followed in its Densities at different Degrees of Dilution; with several new Tables. By* ANDREW URE, *M.D. Professor of Natural Philosophy and Chemistry in the Glasgow Institution, Member of the Geological Society of London, and of the Faculty of Physicians and Surgeons of Glasgow.*

THERE is perhaps no substance which possesses more important relations with chemical science than sulphuric acid; and few are so extensively employed in the chemical arts. The connection between its density and acid strength has been made the subject of many experiments by Kirwan, Vauquelin, Dalton, and other chemists of reputation; but the GENERAL LAW which unites its specific gravity with its degree of dilution, does not seem to have been investigated, far less ascertained. The knowledge of this law would be an important

* Biot's *Traité de Physique*, tom. iv. p. 473, 478.

acquisition to chemical philosophy, and it would also lead to new discoveries of an analagous nature with regard to the other acid, alkaline, and saline combinations with water. How far I have had the good fortune to succeed in this untrodden path, is now respectfully submitted to the scientific world. I was led to examine the subject very minutely, in preparing for publication a general system of chemical instructions, to enable apothecaries, manufacturing chemists, and dealers, to practise analysis with accuracy and dispatch, as far as their respective arts and callings require. I hope that this work will soon appear. Meanwhile the following details will afford a specimen of the experimental researches, executed with this view.

The best commercial sulphuric acid, that I have been able to meet with, contains from one-half to three quarters of a part in the hundred, of solid saline matter, foreign to its nature. These fractional parts consist of sulphate of potash and lead, in the proportion of two of the former to one of the latter. It is, I believe, scarcely possible to manufacture it directly, by the usual methods, of a purer quality. The ordinary acid sold in the shops contains often 3 or 4 per cent. of saline matter. Even more is occasionally introduced by the employment of nitre to remove the brown colour given to the acid by carbonaceous matter. The amount of these adulterations, whether accidental or fraudulent, may be readily determined by evaporating, in a small capsule of porcelain, or rather platina, a definite weight of the acid. The platina cup placed on the red cinders of a common fire, will give an exact result in five minutes. If more than five grains of matter remain from five hundred of acid, we may pronounce it sophisticated.

Distillation is the mode by which pure oil of vitriol is obtained. This process is described in chemical treatises as both difficult and hazardous: but since adopting the following plan, I have found it perfectly safe and convenient. I take a plain glass retort, capable of holding from two to four quarts of water, and put into it about a pint measure of the sulphuric acid, connecting the retort with a large globular

receiver, by means of a glass tube four feet long, and from one to two inches in diameter. The tube fits very loosely at both ends. The retort is placed over a charcoal fire, and the flame is made to play gently on its bottom. When the acid begins to boil smartly, sudden explosions of dense vapour rush forth from time to time, which would infallibly break small vessels. Here, however, these expansions are safely permitted by the large capacity of the retort and receiver, as well as by the easy communication with the air at both ends of the adopter tube. Should the retort, indeed, be exposed to a great intensity of flame, the vapour will no doubt be generated with incoercible rapidity, and break the apparatus. But this accident can proceed only from gross imprudence. It resembles, in suddenness, the explosion of gunpowder, and illustrates admirably Dr. Black's observation, that, but for the great latent heat of steam, a mass of water, powerfully heated, would explode on reaching the boiling temperature. I have ascertained that the specific caloric of the vapour of sulphuric acid is very small, and hence the danger to which rash operators may be exposed during its distillation. Hence, also, it is unnecessary to surround the receiver with cold water, as when alcohol and most other liquids are distilled. Indeed the application of cold to the bottom of the receiver generally causes it, in the present operation, to crack. By the above method I have made the concentrated oil of vitriol flow over in a continuous slender stream, without the globe becoming sensibly hot.

I have frequently boiled the distilled acid till only one-half remained in the retort; yet at the temperature of 60° Fahrenheit, I have never found the specific gravity of acid, so concentrated, to exceed 1.8455. It is, I believe, more exactly 1.8452. The number 1.850, which it has been the fashion to assign for the density of pure oil of vitriol, is undoubtedly very erroneous, and ought to be corrected. Genuine *commercial* acid should never surpass 1.8485; when it is denser, we may infer sophistication, or negligence in the manufacture.

The progressive increase of its density, with saline contamination, will be shewn by the following experiments. To

4,100 grains of genuine commercial acid (but concentrated to onyl1.8350) 40 grains of dry sulphate of potash were added. When the solution was completed the specific gravity at 60° had become 1.8417. We see that at these densities the addition of 0.01 of salt, increases the specific gravity by about 0.0067. To the above 4.140 grains other 80 grains of sulphate were added, and the specific gravity, after solution, was found to be 1.8526 We perceive that somewhat more salt is now required to produce a proportional increase of density; 0.01 of the former changing the latter by only 0.0055. Five hundred grains of this acid being evaporated in a platina capsule left $16\frac{1}{2}$ grains; whence the composition was

Sulphate of potash, with a little sulphate of lead,	3.30
Water of dilution, - -	5.3
Oil of vitriol of 1.8485, - -	91.4
	100.0

Thus, acid of 1.8526, which in commerce would have been accounted very strong, contained little more than 91 per cent. of genuine acid.

Into the last acid more sulphate of potash was introduced, and solution being favoured by digestion in a moderate heat, the specific gravity became at 60°, 1.9120. Of this compound, 300 grains, evaporated in the platina capsule, left 41 grains of gently ignited saline matter. We have, therefore, nearly 14 per cent. On the specific gravity in this interval, an increase of 0.0054 was effected by 0.01 of sulphate.* This liquid

was composed of saline matter, - - -	14.
Water of dilution, - - - -	4.7
Oil of vitriol of 1.8485, - - -	81.3
	100.0

The general proportion between the density and impurity may be stated at 0.0055 of the former to 0.01 of the latter.

If from genuine oil of vitriol, containing $\frac{1}{4}$ of a per cent. of saline matter, a considerable quantity of acid be distilled off, what remains in the retort will be found very dense. At the specific gravity 1.865, such acid contains $3\frac{1}{2}$ of solid salt in the

100 parts. The rest is pure concentrated acid. From such heavy acid, at the end of a few days, some minute crystals will be deposited, after which its specific gravity becomes 1.860, and its transparency is perfect. It contains about $2\frac{1}{2}$ per cent. of saline matter. Hence if the chemist employ for his researches an acid which, though originally pretty genuine, has been exposed to long ebullition, he will fall into great errors. From the last experiments it appears that *concentrated* oil of vitriol can take up only a little saline matter in comparison with that which is somewhat dilute. It is also evident, that those who trust to specific gravity alone, for ascertaining the value of oil of vitriol, are liable to great impositions.

The saline impregnation exercises an important influence on all the densities at subsequent degrees of dilution. Thus, the heavy impure *concentrated* acid, specific gravity 1.8650, being added to water in the proportion of one part to ten, by weight, gave, after twenty-four hours, a compound whose specific gravity was 1.064. But the most concentrated genuine acid, as well as distilled acid, by the same degree of dilution, namely 1+10, acquires the specific gravity of only 1.0602, while that of 1.852, containing, as stated above, $3\frac{1}{2}$ per cent. of sulphate of potash combined with acid of 1.835, gives, on a similar dilution, 1.058. This difference, though very obvious to good instruments, is inappreciable by ordinary commercial apparatus. Hence this mode of ascertaining the value of an acid, recommended by Mr. Dalton, is inadequate to detect a deterioration of even 8 or 9 per cent. Had a little more salt been present in the acid, the specific gravity of the dilute, in this case, would have equalled that of the genuine. On my acidimeter one per cent. of deterioration could not fail to be detected, even by those ignorant of science.

The quantity of oxide, or rather sulphate of lead, which sulphuric acid can take up, is much more limited than is commonly imagined. To the concentrated oil of vitriol I added much carbonate of lead, and after digestion by a gentle heat, in a close vessel, for twenty-four hours, with occasional agitation its specific gravity, when taken at 60°, was scarcely

greater than before the experiment. It contained about 0.005 of sulphate of lead.

The quantity of water present in 100 parts of concentrated and pure oil of vitriol, seems to be very exactly 18.46. The mean of my most satisfactory experiments on the composition of sulphate of potash, gave 18.5, differing scarcely from the above, deduced from the theory of multiple proportions, hypothetically called the Atomic theory. The composition of the sulphate itself, by one experiment, was 45.4 acid + 54.6 potash

In another,	- - -	45.6	+	54.4	
Mean	- - -	45.5	+	54.5	= 100

Relative to the weight of pure oil of vitriol required for the saturation of 100 grains of ignited subcarbonate of potash, (from tartar and crystallized bicarbonate) my experiments have been very numerous. I am convinced that instead of 71, the number given on Dr. Wollaston's admirable scale, as equivalent to 100 of subcarbonate, we should make it, 70.4.

In estimating the combined water of pure oil of vitriol, by the synthesis of sulphate of soda, we have a little more difficulty to encounter; since absolutely pure subcarbonate of soda is less readily found than that of potash. One hundred grains of very pure subcarbonate of soda, neutralized from 91 to 91.4 grains of distilled sulphuric acid. The resulting sulphate gently ignited, consists of 55.55 acid + 44.45 soda = 100. Hence 100 of dry acid, correspond to 80 of soda. On Dr. Wollaston's scale, 100 are equivalent to 78. I have not been able to find any specimen of subcarbonate of soda, of which, as stated by Dr. Wollaston, 100 grains would neutralize 93, or 92.7 of pure oil of vitriol. The singular discernment displayed by this philosopher in the determination of the relative proportions for his scale, and their general accuracy, made me hesitate in adopting a number so different as 91, or 91.4, till I had verified it by frequent repetition of the experiments.

The proportional weights of the atoms of the three bodies, soda, sulphuric acid, and potash, whose combinations we have

just now investigated, seem to be 4, 5, and 6; while the weights of their *constituent* atoms, including sulphurous acid, are the arithmetical series, 1, 2, 3, 4, 5,—numbers which, from their great simplicity, cannot be forgotten.

In the experiments executed, to determine the relation between the density of diluted oil of vitriol, and its acid strength, I employed a series of phials, numbered with a diamond. Into each phial, recently boiled acid, and pure water, were mixed in the successive proportions, of 99 + 1, 98 + 2, 97 + 3, &c. through the whole range of digits down to 1 acid + 99 water. The phials were occasionally agitated during 24 hours, after which the specific gravity was taken. The acid was genuine and well concentrated. Its sp. gr. was 1.8485. Some of the phials were kept with their acid contents, for a week or two, but no further change in the density took place. The strongest possible *distilled* acid, was employed for a few points, and gave the same results as the other.

Of the three well known modes of ascertaining the specific gravity of a liquid, namely, that by Fahrenheit's hydrometer; by weighing a vessel of known capacity filled with it; and by poising a glass ball, suspended by a fine platina wire from the arm of a delicate balance; I decidedly prefer the last. The corrosiveness, viscidity, and weight of oil of vitriol, render the first two methods ineligible; whereas, by a ball floating in a liquid, of which the specific gravity does not differ much from its own, the balance, little loaded, retains its whole sensibility, and will give the most accurate consistency of results.

In taking the specific gravity of concentrated or slightly diluted acid, the temperature must be minutely regulated, because from the small specific heat of the acid, it is easily affected, and because it greatly influences the density. On removing the thermometer, it will speedily rise in the air to 75° or 80°, though the temperature of the apartment be only 60°. Afterwards it will slowly fall, to perhaps 60° or 62°. If this thermometer, having its bulb covered with a film of dilute acid (from absorption of atmospheric moisture) be plunged into a strong acid, it will instantly rise 10° or more,

above the real temperature of the liquid. This source of embarrassment and occasional error, is obviated by wiping the bulb after every immersion. An elevation of temperature, equal to 10° Fahr., diminishes the density of oil of vitriol by 0.005. 1000 parts being heated from 60° to 212° become 1.043 in volume, as I ascertained by very careful experiments. The specific gravity, which was 1.848, becomes only 1.772; being the number corresponding to a dilution of 14 per cent. of water. The viscidity of oil of vitriol, which below 50° is such, as to render it difficult to determine the specific gravity by a floating ball, diminishes very rapidly as the temperature rises; evincing that it is a modification of cohesive attraction.

The following table of densities, corresponding to degrees of dilution, was the result in each point of a particular experiment, and was, moreover, verified in a number of its terms, by the further dilution of an acid, having previously combined with it, a known proportion of water. The balance was accurate and sensible.

In order to discover the *general law* (hitherto unknown) which connects the density and state of dilution, I compared by the method of interpolating series, the numbers of the experimental table, with those adjoining, as well as those somewhat distant. For example, I deduced by the formula, $a - 4b + 6c - 4d + e = 0$, the specific gravity at 60 per cent: 1st, from the 4 nearest quantities of 58, 59, 61, 62; 2dly, from those less near of 50, 55, 65, 70; and thirdly, from those more remote corresponding to 40, 50, 70, 80. A similar ordeal was applied to every fifth specific gravity in the whole table. Anomalies appeared not a little perplexing. I next proceeded to compare the actual specific gravities with the mean densities of the components, when a very beautiful curve of condensation unfolded itself. Table II. exhibits this relation in a distinct manner.

TABLE I.

The Quantity of Oil of Vitriol, and dry sulphuric Acid, in 100 parts of dilute, at different Densities.

Liquid.	Sp. Gr.	Dry.	Liquid.	Sp. Gr.	Dry.	Liquid.	Sp Gr.	Dry.
100	1.8485	81.54	66	1.5503	53.82	32	1.2334	26.09
99	1.8475	80.72	65	1.5390	53.00	31	1.2260	25.28
98	1.8460	79.90	64	1.5280	52.18	30	1.2184	24.46
97	1.8439	79.09	63	1.5170	51.37	29	1.2108	23.65
96	1.8410	78.28	62	1.5066	50.55	28	1.2032	22.83
95	1.8376	77.46	61	1.4960	49.74	27	1.1956	22.01
94	1.8336	76.65	60	1.4860	48.92	26	1.1876	21.20
93	1.8290	75.83	59	1.4760	48.11	25	1.1792	20.38
92	1.8233	75.02	58	1.4660	47.29	24	1.1706	19.57
91	1.8179	74.20	57	1.4560	46.48	23	1.1626	18.75
90	1.8115	73.39	56	1.4460	45.66	22	1.1549	17.94
89	1.8043	72.57	55	1.4360	44.85	21	1.1480	17.12
88	1.7962	71.75	54	1.4265	44.03	20	1.1410	16.31
87	1.7870	70.94	53	1.4170	43.22	19	1.1330	15.49
86	1.7774	70.12	52	1.4073	42.40	18	1.1246	14.68
85	1.7673	69.31	51	1.3977	41.58	17	1.1165	13.86
84	1.7570	68.49	50	1.3884	40.77	16	1.1090	13.05
83	1.7465	67.68	49	1.3788	39.95	15	1.1019	12.23
82	1.7360	66.86	48	1.3697	39.14	14	1.0953	11.41
81	1.7245	66.05	47	1.3612	38.32	13	1.0887	10.60
80	1.7120	65.23	46	1.3530	37.51	12	1.0809	9.78
79	1.6993	64.42	45	1.3440	36.69	11	1.0743	8.97
78	1.6870	63.60	44	1.3345	35.88	10	1.0682	8.15
77	1.6750	62.78	43	1.3255	35.06	9	1.0614	7.34
76	1.6630	61.97	42	1.3165	34.25	8	1.0544	6.52
75	1.6520	61.15	41	1.3080	33.43	7	1.0477	5.71
74	1.6415	60.34	40	1.2999	32.61	6	1.0405	4.89
73	1.6321	59.52	39	1.2913	31.80	5	1.0336	4.08
72	1.6204	58.71	38	1.2826	30.98	4	1.0268	3.26
71	1.6090	57.89	37	1.2740	30.17	3	1.0206	2.446
70	1.5975	57.08	36	1.2654	29.35	2	1.0140	1.63
69	1.5868	56.26	35	1.2572	28.54	1	1.0074	0.8154
68	1.5760	55.45	34	1.2490	27.72			
67	1.5648	54.63	33	1.2409	26.91			

In order to compare the densities of the preceding dilute acid, with those of distilled and again concentrated acid, I mixed one part of the latter with nine of pure water, and after agitation, and a proper interval, to ensure thorough combination, I found its specific gravity as above, 1.0682: greater density indicates saline contamination.

100 parts of sulphuric acid sp. gr. 18485, occupy a volume compared with 100 of water, of 54.1. Hence 100 gr. acid + 100 gr. water, will compose in bulk 154.1 gr. measures; and the arithmetical density compared to that of water will be $\frac{200}{154.1} = 1.2978$. On this principle, the second column of the following table, is constructed; which presents the mean specific gravity deduced from that of the components.

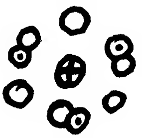
TABLE II.

Mean and experimental specific Gravities compared.

Liquid Acid in 100.	Mean sp. gr. of components.	Sp. gravity by experiment.	Resulting volume.	Liquid Acid in 100.	Mean sp. gr. of components.	Sp. gravity by experiment.	Resulting volume.
100	1.8485	1.8485	100.00	60	1.3800	1.4860	92.87
95	1.7732	1.8376	96.50	50	1.2978	1.3884	93.47
90	1.7039	1.8115	94 06	40	1.2249	1.2999	94.23
80	1.5803	1.7120	92.35	30	1.1597	1.2184	95.18
74	1.5143	1.6415	92.25	20	1.1011	1.1410	96.50
73	1.5039	1.6321	92.14	10	1.0481	1.0680	98.13
72	1.4936	1.6204	92.17	5	1.02348	1.0336	99.02
70	1.4734	1.5975	92.23				

Dilute acid, having a specific gravity = 1.6321, has suffered the greatest condensation; 100 parts in bulk have become 92.14. If either more or less acid exist in the compound, the volume will be increased. What reason can be assigned for the maximum condensation occurring, at this particular term of dilution? The above dilute acid consists of 73 per cent. of oil of vitriol, and 27 of water. But 73 of the former, contains by Table I. 59.52 of dry acid, and 13 48 of water. Hence 100 of the dilute acid, consist of 59,62 of dry acid, + 13.48 × 3 = 40.44 of water = 99.96; or it is a compound, of one atom of dry acid, with three atoms of water. Dry sulphuric acid consists of 3 atoms of oxygen, united to 1 of sulphur. Here, each atom of oxygen, is associated with one

of water, forming the symmetrical arrangement, represented by the following symbol.



The contemplation of the figure, will shew clearly that the least deviation, from the above definite proportions, must impair the balance of the attractive forces, whence they will act less efficaciously, and therefore produce less condensation. We now see the reason, why by an interpolation of numbers, deduced from the more remote terms in the series, we should have results, different from those, obtained by including only the proximate terms in the calculation. The succession of the numbers, constitutes no strict geometrical, but a chemical chain, the relation of whose links, must be sought for, not altogether in Algebra, but in the interior constitution of the combining bodies. Yet we need not despair, of discovering some general principle, so connecting the specific gravity, with the proportion of the components, as to enable us to approximate by calculation, very nearly to the results of experiment. The discovery of such general laws, is the highest function, and noblest end of philosophy.

Since the quantity of condensation, varies very remarkably, with the degree of dilution, and since the diminution of volume, will change more or less the relations of the acid to heat, it is evidently illogical, to deduce *general* inferences concerning the doctrines of specific caloric, as many chemists have done, from a compound, whose physical constitution, is so variable, by varying the state of dilution. Whatever proposition may be experimentally established, for any one density, cannot be extended to another, without violating every principle of philosophical analogy and induction.

For comparing, in the preceding table, the experimental and mean densities, had we employed the common method of deducing the latter, we should have been led into a curious labyrinth of error. If gold and silver be united in equal weights, the *mean* specific gravity will be $\frac{19.3 + 10.5}{2} = 14.9$; if lead

and tin, it will be $\frac{11.3 + 7.3}{2} = 9.3$; and these numbers arithmetically found, being compared with the specific gravities *experimentally* obtained, will shew what change of volume the alloy has undergone. If sulphuric acid and water be mixed in equal weights, then in like manner, the mean density should be $\frac{1.8480 + 10000}{2} = 1.4240$. But experiment gives for the density, at the term of equal weights, only 1.3884, indicating that the arithmetical specific gravity is greater than the experimental, whence the volume should be augmented, instead of being diminished, as it really is. The following table shews the general results of this method.

TABLE III.

Acid in 100.	Mean density	Experimental density.	Change of volume.	Acid in 100.	Mean density.	Experimental density.	Change of volume.
100		1.8480	100	50	1.4240	1.3884	102.6
90	1.7632	1.8115	97.3	40	1.3392	1.2999	103.02
80	1.6784	1.7120	98.0	30	1.2544	1.2184	102.95
70	1.5936	1.5975	99.7	20	1.1696	1.1410	102.50
60	1.5088	1.4860	101.5	10	1.0848	1.0680	101.57

Here, 2 of acid + 1 of water, give a *mean* specific gravity, exactly equal to the experimental; shewing apparently, that no change of volume takes place with these proportions; 2 of water + 1 of acid, give the greatest augmentation of volume, being 103.24. The maximum density seems to be at 88 acid + 12 water. Yet all these results are certainly false and illusory; for I have found by mingling 2 parts of water with 1 of acid by weight, in a graduated glass tube, that there is a condensation of 100 in bulk, into about 95; instead of an augmentation of 100 into 103.24, as the above calculation gives reason to expect.

The very minute and patient examination, which I was thus induced to bestow on the table of specific gravities, disclosed to me the general law pervading the whole, and consequently the means of inferring the density from the degree of dilution, as also of solving the inverse proposition.

If we take the specific gravity, corresponding to 10 per cent. of oil of vitriol, or 1.0682 as the root; then the specific

gravities at the successive terms of 20, 30, 40, &c. will be the successive powers of that root. The terms of dilution, are like logarithms, a series of numbers in arithmetical progression, corresponding, to another series, namely, the specific gravities, in geometrical progression. For a little distance on both sides of the point of greatest condensation, the series converges with accelerated velocity, whence the ten or twelve terms on either hand, deviate a little from experiment. For these, indeed, the root should be 1.0694. When the proportion of acid exceeds 90 per cent. we require a particular rule, which is however extremely simple. It consists in adding to the calculated specific gravity for 90, by the general law, the following series for each successive digit, up to concentrated oil of vitriol, — 0,007, 0.006, 0.005, 0.005, 0.004, 0.003, 0.0025, 2, 2, 1. The reason of this series will be found in the rapid flexure of the curve of condensation in the interval from 90 to 100; in which ten terms, it describes an arch as great, as in the 45 terms at the lower end of the table. Or in other words, 10 of water added to 90 of acid, produce as great a diminution, in the calorific tension of the compound, as 55 of acid, added to 45 of water.

TABLE IV.

Exhibiting a comparative View of the specific Gravities of dilute sulphuric Acid, as derived from Experiment, and Calculation.

Acid per cent.	Experimental density.	Calculated density.	Acid per cent.	Experimental density.	Calculated density.
100	1.8485	1.8485			
99	1.8475	1.8475	65	1.5390	1.5355
98	1.8460	1.8455	60	1.4860	1.4857
97	1.8439	1.8435	55	1.4360	1.4375
96	1.8410	1.8410	50	1.3884	1 3908
95	1.8376	1.8380	45	1.3440	1.3457
94	1.8336	1.8340	40	1.2999	1.3020
93	1.8290	1.8290	35	1.2572	1.2597
92	1.8233	1.8240	30	1.2184	1.2189
91	1.8179	1.8180	25	1.1792	1.1793
90	1.8115	1.8110	20	1.1410	1.1410
85	1.7673	1.7689	15	1.1019	1.1040
80	1.7120	1.7105	10	1.0682	1.0682
75	1.6520	1.6541	5	1.0336	1.0335
70	1.5975	1.5990	0	1.0000	1.0000

Up to 60 per cent. of acid, I believe the calculated specific gravities to deserve as great confidence as any which we can derive from experiment; and if from 65 to 85, we make the slight modification on the root above mentioned, an excellent accordance is obtained; as the comparison of the columns will shew.

The computed numbers may be obtained by common arithmetic, for $1.0682^2 = 1.1410$; $1.0682^3 = 1.2189$; and $1.0682^{5.5} = 1.4375$; they are found, however, with incomparably greater facility by any table of logarithms.

The general formula which I deduced for the calculation is, $S = r^n \pm \frac{d}{144} r^n$, where S = specific gravity, $r = 1.0682$, $n =$ the decade of acid strength, and $d =$ digits intermediate between two successive decades. Thus for 36 of acid per cent. $n = 3$, and $d = +6$; or, $n = 4$, $d = -4$.

The simplest logarithmic formula which I have been able to contrive, is the following.

Log. $S = \frac{2\,a}{700}$, where S is the specific gravity, and a the per centage of acid.

And $a =$ Log. S $\times$ 350.

In common language, the two rules may be stated thus.

Problem 1st, To find the proportion of oil of vitriol in dilute acid of a given specific gravity. Multiply the logarithm of the specific gravity by 350, the product is directly the per centage of acid.

If the dry acid be sought, we must multiply the logarithm of the specific gravity by 285; and the product will be the answer.

Problem 2d, To find the specific gravity corresponding to a given proportion of acid. Multiply the quantity of acid by 2, and divide by 700; the quotient is the logarithm of the specific gravity. These rules are modifications of the first formula.

Example 1st, Specific gravity is 1.3612. What is the per centage of liquid acid?

Log. of 1.3612 is 0.13392, which, multiplied by 350, gives 46.87.

By table I. sp. gr. 1.3612 = 47.

Example 2d, Sp. gr. 1.1876. Proportion of liquid acid sought?

Log. of 1.1876 = 0.07467 × 350 = 26.13.

Experiment gives at this density 26.00.

Example 3d, Sp. gr. 1.8179. What is the proportion of acid and water?

Log. of 1.8179 is 0.25957 ∴ 0.25957 × 350 = 90.85 + 9.15 water.

By the table we have 91.00 + 9.00

Example 4th, Sp. gr. is 1.4860; required the proportion of dry acid?

Log. of 1.4860 is 0.1719 ∴ 0.1719 × 285 = 48.99.

Experiment makes it 48.92.

Example 5th, What is the specific gravity corresponding to 8 of acid per cent.?

$$8 \times \frac{2}{700} = 0.022857,$$ which is the logarithm of 1.0540.

By experiment we find 1.0544.

Example 6th, What density corresponds to 54 acid + 46 water?

$$54 \times \frac{2}{700} = 0.15428,$$ which is the logarithm of 1.4265.

By the table at 54 = 1.4265.

These examples amply demonstrate the simplicity and general accuracy of the above formula. I do not imagine that at any point, an error amounting to 1 per cent. can be found.

TABLE V.

Comparative View of the Quantity of dry Acid in 100, of different Densities.

Specific gravity.	Kirwan.	Difference.	Dalton.	Difference.	Ure.	Difference.	Oil of vitriol in 100
1.8485	79.00		79.5		81.54		100
1.8115	76.23	2.77	71.1	8.39	73.39	8.15	90
1.7120	68.00	8.23	62.8	8.31	65.23	8.16	80
1.5975	57.64	10.36	55.13	7.67	57.08	8.15	70
1.4860	46.60	11.04	47.00	8.13	48.92	8.16	60
1.3884	40.24	6.36	38.20	8.80	40.77	8.15	50
1.2999	31.55	8.69	30.00	8.20	32.61	8.16	40
1.2184	23.80	7.75	21.70	8.30	24.46	8.15	30
1.1410	16.07	7.73	14.00	7.70	16.31	8.15	20
1.0682	7.20	8.87	6.70	7.30	8.15	8.16	10

Those who have perused the preceding pages with moderate attention, will readily allow, I presume, that my succession of specific gravities in the first column, corresponding to the per centage of oil of vitriol in the last, follows a regular progression in acid dilution. Now, nothing more is required for demonstrating the errors which Mr. Kirwan and Mr. Dalton, have committed in the construction of their tables, hitherto accounted standard, and as such, disseminated through all our chemical systems. Instead of finding the differences of their specific gravities uniform, or nearly so, as they ought undoubtedly to be, their differential columns discover great irregularities and inconsistencies. In addition to these errors betrayed by internal evidence, there is another of no less magnitude, occasioned by their estimating the density of concentrated acid far too high. Hence, at the specific gravity of 1.8485, the one has already disposed of 2.54 parts of acid, and the other of 2.04; yet it is undeniable, that *pure* acid, of the utmost concentration, containing the whole 81.54 parts of dry acid, does not possess even so great a density. Well boiled distilled oil of vitriol, which gives, by the synthesis of sulphate of potash, 81.54 per cent. of dry acid, has not even the specific gravity, 1.8460. Indeed, had I placed this density at the head of my table, as in strict reasoning I should have done, their deviations would have become still more conspicuous. As my table, however, is intended not only for the scientific chemist, but for commercial purposes, it was incumbent on me to take *genuine commercial* acid, as the subject of my experiments. Below 90 per cent. of oil of vitriol, the specific gravities obtained from the dilution of such acid, and that which has been distilled, become nearly the same.

For an exposure of errors equally considerable, in the generally received tables of the same two chemists on muriatic acid, the reader is referred to my experimental researches on hydrochloric acid and the chlorides, in the Annals of Philosophy.

Their table of nitric acid is equally erroneous, as I shall shew in a separate memoir on the subject, in which the law of its condensation will be developed.

Art. XIII. *Proceedings of the Royal Society of London.*

Thursday, June 5. Dr. Leach communicated some observations on the genus Ocythoë, of Rafinesque. It has been a question with naturalists whether the Ocythoe, which is frequently found in the paper nautilus, is the real inhabitant and fabricator of that delicate shell, or a mere parasitic inhabitant. Sir Joseph Banks's observations long ago led him to the latter opinion, and the specimens recently brought to England by the gentlemen of the Congo expedition, have enabled Dr. Leach very satisfactorily to demonstrate the truth of the President's opinion.

At the same meeting, a paper relating to the same subject was read by Sir E. Home. It described the mode in which the blood is aerated in the sepia, as contrasted with that of the shell vermes, and from this source he was enabled to furnish additional evidence as to the correctness of the opinions set forth in the last paper.

June 12, *and June* 19. These meetings were occupied with the reading of a long communication from Sir William Herschel, on the structure of the heavens. It related principally to the distribution or scattering of the stars in space—to their division into classes of magnitudes—to their brightness and distance, and to the extent and structure of the milky way.

On Thursday the 26th of June, Sir Everard Home presented an account of the nests of the Java swallow, proving that the material of which they are composed, is a secretion from the crop of the bird.—He also gave in a paper on the glandular structure of the human stomach, which, as well as the former, was illustrated by some very beautiful drawings, from the pencil of Mr. Bauer.

Dr. Rawlins Johnson communicated to the Society his observations on the anatomy and habits of the Hirudo Complanata, and Hirudo Stagnalis, which he now refers to a distinct genus, under the name of *Glossiphonia.*

A letter was read, addressed by William Sewell, Esq. to the President, on the cure of a diseased foot in the horse, resulting from an injury done to the coffin bone.

The Astronomer Royal gave in his observations relating to the

parallax of the fixed stars, whence it appeared that the continuation of his former accurate researches offered no evidence whatever of the existence of parallax in the fixed stars which he examined.

The President then adjourned the present session of the Royal Society.

The gold and silver medals on Count Rumford's donation, have this year been adjudged, by the President and Council of the Royal Society, to Sir Humphry Davy, for his various communications on the subjects of flame and combustion, printed in the Philosophical Transactions.

Art. XIV. *Royal Institution.*

We stated in a former Number, that strong hopes were entertained that the mechanical department of science in this place would become an object of consideration, and that means were contemplated for enabling it to keep pace with the progress of the chemical researches and discoveries which have emanated from the Royal Institution.

With a view to the furtherance of this object, which has hitherto been neglected, John Millington, Esq. who has been the lecturer on mechanical subjects in this place for the three last seasons, has been appointed Professor of Mechanics, and the various instruments and machines connected with this department have been placed under his care and superintendance.

The Royal Institution already possesses an extensive and valuable collection of instruments and apparatus, but it is to be lamented, that this collection is very limited in models of the various machinery used in our manufactures and arts, by which the principles of science are applied to the useful purposes of life, and which is an object of the first importance to a manufacturing and commercial country, and was indeed one

of the leading features of the Royal Institution at its foundation.

Mr. Millington has particularly directed his attention to the supply of this deficiency, which has arisen from two causes, viz. the want of sufficient funds, by which such articles could be obtained, and the want of a permanent person, sufficiently versed in the actual manipulations of art, to instruct and explain them, and bring them into a state of useful activity; for, since the lectures which were delivered by Mr. Powell of Cambridge, upon the models obligingly lent by Professor Farish, this useful and important branch of knowledge has lain dormant in this place until revived by Mr. Millington in his lectures of the two last seasons.

The importance and necessity of repairing and completing the present collection of models and instruments, and increasing them, by the addition of all that may be new and curious in the mechanic arts, has been sufficiently felt and appreciated by many members, subscribers, and friends to the Institution, who have set a subscription on foot for the purpose of accomplishing this desirable object. More than 50*l.* have already been received, with which a workshop has been established, and furnished with tools, in the house of the Institution, and several new and useful models have been purchased and made, and it is confidently hoped, that when the benefits to be derived from this fund (which is placed under the direction of Mr. Millington, subject to the approval and examination of the board of Managers), are sufficiently known and investigated, that it will be extended to meet all the objects it was meant to embrace, which, among other things, will be to form the large repository into a museum of models and machines applicable to all the most useful purposes of the arts and manufactures, which will thus be concentrated and opened to all the members and subscribers to the Royal Institution; and all persons inclined to make presents to the Institution, of models, machines, implements, or productions of art, will not only confer an obligation, but will promote this object, while such presents, with an account of their uses, will be carefully preserved and recorded, with the names

of the donors, which will, in future, be published half yearly in this Journal.

The Institution has already to return thanks to Thomas Telford, Esq. for a print of the elevation of the iron chain bridge proposed to be constructed by him over the Runcorn Gap, near Liverpool, in which the centre arch, or rather opening, is to be 1000 feet, and the two lateral ones each 500 feet, while the elevation will be such as to permit ships to sail underneath it; also to Peter Schmidtmeyer, Esq. for a model of a new drag, or machine, of the nature of a plough, which has been successfully used in the neighbourhood of Bagshot, for filling up ruts and repairing roads, to be worked by one or more horses.

The President and Managers of the Royal Institution, anxious to adopt those measures which may be most conducive to its benefit, as well as to the advancement of science, instituted evening meetings in the Great Library, which were held every Monday during the last season, and are to be recommenced in the ensuing season, on the first Monday in February, and continued on each succeeding Monday, (the Easter holydays excepted) until the first Monday in July, 1818. These meetings are open to the members of the Institution, and to such persons as they wish to introduce for the purpose of trying experiments, exhibiting specimens of novelty and curiosity connected with the Sciences and Arts, and discussing the same, together with any researches or discoveries which may from time to time be produced.

Among other matters of interest which have been produced at these meetings, we cannot omit noticing the experiments upon congelation, by means of absorbents, made by James Stodart, Esq., in consequence of a communication from Professor Leslie, of Edinburgh.

The process of producing ice, or freezing water, under the receiver of an air pump, by exposing it to the absorbent powers of concentrated sulphuric acid, has long been known, and this experiment induced a supposition, that pipe clay and other absorbent earths, might produce a similar effect: accordingly, this and the Trap Rock, of Calton Hill, near Edin-

burgh, were tried by Professor Leslie, and found to answer the purpose. In the progress of his experiments, he observed, that the common coarse Scotch oatmeal, when dried before a fire, or in a kiln, but not over heated, was powerfully absorbent, and on being applied to the same purpose, answered most effectually. A tin case of this, and another of the Calton Hill trap rock, previously dried and soldered up, were forwarded by Professor Leslie to Mr. Stodart, and with these, the experiment above mentioned was tried, with a powerful and excellent air pump, belonging to Mr. Leslie, which has three plates. Three substances were made use of, viz. the above oatmeal, trap rock, and dried tobacco pipe clay, disposed in common dinner plates. The water was contained in small unglazed Wedgewood pans, 3 inches deep each, while the water in them was half an inch deep. These pans were supported upon wire frames, a small distance over the absorbents, and a small thermometer was placed in each. In this state, they were covered with hemispherical glass receivers, and on working the pump, and producing a good vacuum, the water over the oatmeal, became a solid cake of ice in eleven minutes; that over the trap rock in 13 minutes, and that over the pipe clay, shot into crystals of ice in about the same time, but did not entirely freeze. This was in June, and the thermometer in the room was at 67.

The construction and properties of Bramah's patent lock, in which the confidence of the public has so long reposed, became also a subject of discussion at these meetings, on account of that confidence having been somewhat disturbed by an advertisement in some of the public prints, from a person who offered to pick or open any of them for a small sum.*

Mr. Bramah attended, and lent a large model, explanatory

* Mr. Bramah immediately sent 500 of his locks, to the Crown and Anchor Tavern, and called a meeting, by public advertisement, of all mechanics who were inclined to try their skill, offering a reward of 500 guineas to that person who should pick or open any one of them. This meeting took place on the 22d of May last, when the locks resisted all attempts which were made upon them.

of the principles of his late father's lock, and his own improvements upon it, to the Institution, when every one was satisfied with the almost utter impossibility of opening locks upon his construction, their security depending upon the doctrine of combinations or multiplication of numbers into each other, which is known to increase in the most rapid proportion. Thus a lock of five sliders, admits of 3000 variations, while one of eight, which are commonly made, will have no less than 1,935,360 changes, or, in other words, that number of attempts at making a key, or at picking it, may be made, before it can be opened. Such was the case in the life time of its late ingenious inventor, but by the simple improvement of his sons, the present manufacturers, this difficulty may be increased in an hundred fold, or greater proportion, without at all adding to the complication of the lock, and deserves a more particular description than our limits will admit of, or than we feel at liberty to lay before the public, without the immediate permission of the proprietors and inventors. It will be sufficient, therefore, to say, that Bramah's lock, in its present state of improvement, may be implicitly confided in, as being one of the simplest and most perfect inventions of the kind we are acquainted with, since it now presents no clue or indication by which the most distant idea of the form into which its moveable wards or sliders must be thrown, in order to open it, and at some future period, if it meets the wishes of the proprietors, we may be inclined to give an account of the simple and important improvement which it has lately received.

M. Biot, whose researches on the polarization of light, are already before the public, kindly attended at the Institution, and repeated a number of his own, and Dr. Brewster's experiments on the passage of light, through several crystallized and uncrystallised media, essential oils, &c. Many new and curious minerals and machines have been presented and examined, at these meetings, particularly Mr. James Lees, and Messrs. Hill and Bundy's new patent machinery for dressing and preparing flax and hemp.—Mr. John Sewell's new machine for spinning, without probability of error.—Mr. Paulli's

new fire arms, which ignite the gunpowder by sudden and violent condensation of air, without flint or steel. The important improvements in Sir Humphry Davy's lamp,—Sir William Congreve's hydro-pneumatic lock for canals, and its compensation apparatus,—a new refrigeratory for distillation of coal gas or other products.—The hydraulic ram of Mongolfier, and many other new and curious articles.

The lectures delivered in the Theatre of the Institution during the last season, consisted of a course of mineralogical and analytical Chemistry, and the arts connected with these subjects, by William Thomas Brande, Esq. Prof. Chem. R. I. &c. A course on practical mechanics, by John Millington, Esq. Civil Engineer, Prof. Mechanics, R. I.—A course on the Aboriginal Antiquities of Great Britain, by Thomas Stackhouse, Esq.—A course on Drawing and Painting, by W. M. Craig, Esq.—A course on Botany, by Sir James Edward Smith, M. D. F. R. S. &c. and a course on Architecture, by John Soane, Esq. R. A. Professor of Architecture, in the Royal Academy, &c. &c.

Mr. Millington's course on Practical Mechanics, consisted of 16 lectures, being a continuation of 14 on the same subject, delivered by him in the preceding seasons, which when completed by 8 or 9 lectures more, that are to follow in the ensuing season, will form a complete and comprehensive examination of this important and useful branch of science.

The simplest objects were first considered, and the deductions drawn from these were preserved, and gradually applied to the explanation and developement of succeeding, and more intricate results, and thus a chain of connection and communication was preserved and maintained throughout the whole. Mr. Millington grounded the doctrines contained in this course upon the explanation of the simple mechanic powers which were given in the first four lectures, and illustrated in their actions by the usual apparatus and diagrams. The *lever* under its various forms or modifications, was particularly dwelt upon, as being not only one of the most useful, but most commonly resorted to by nature in the production of her various effects, and therefore the most necessary to be

clearly understood in all its operations. It is not however necessary to notice either the examples or demonstrations which were given on this subject, since little or nothing of originality could be expected to occur in elementary lectures, we shall therefore merely proceed to notice the order in which the subjects were introduced, dwelling only upon those which, from not being immediately before the public, can alone be interesting.

Mr. Millington commenced the second division of his subject by devoting an entire lecture to the history of the rise and progress of the mechanical arts in this country, from the earliest antiquity to the death of that celebrated engineer, John Smeaton, Esq. and through the kindness of his daughter Mrs. Dixon, was permitted to exhibit the original model from which the Edystone Lighthouse was built, and which is now in her possession. He then proceeded to point out the high perfection which the various mechanic arts had attained in this country, and some of the means by which this desirable end was effected, and how far the establishment of the Royal Society,—the Society for the Encouragement of Arts, Manufactures and Commerce,—the Royal Institution, and other Public Institutions had assisted,—To the Society for the encouragement of Arts and Manufactures, he expressed his acknowledgments for the liberal manner in which they had lent such part of their valuable and extensive collection of models to the Royal Institution, as he might want for illustration, and he concluded this lecture by some pertinent remarks on the laws of patents for inventions as they at present stand in Great Britain, and by soliciting the attention of the legislature to their revisal, the necessity of which had even been pointed out by the Judges themselves.

As the objects of the mechanic powers are to produce motion and counteract the effect of gravitation and its consequence, weight, these were next examined, together with the nature of that point called the centre of gravity. This investigation was followed up by that of the ability of bodies to support or sustain weights in an examination of the strength and application of materials both to the purposes of building and the

construction of machines. Among the vegetable fibres noticed were those of hemp, flax, the yucca aloe, the South American aloe, the Hop stalk, Indian grass, &c. and the modes of increasing the strength of these by twisting or spinning, was shewn to depend upon the lateral friction produced among the fibres. This, though it increases the general strength, does not augment it in the exact proportion of the number of fibres employed, inasmuch as the strain becomes somewhat changed from a perpendicular into an oblique one; an effect which encreases with the diameter of the rope, which will be found weaker than the separate yarns which compose it; in some cases in as great a proportion as 4 to 3. The late ingenious Captain James Huddart in a great measure succeeded in removing this inconvenience by his patent process and machinery for laying or twisting large ropes and cables. His process, consisting of a certain disposition of his primitive yarns upon rollers, and passing them through a metal plate called a regulator, was explained, and his machinery for spinning illustrated by a model of Sylvester's rope machine from the Society of Arts. By this process, although it is impossible to get rid of the lateral strain in large ropes, yet an equal strain is thrown upon each separate yarn, which in the king's yards is estimated as equivalent to bearing 1 cwt.; and thus the strength of the rope is materially increased.

The tenacity of metals was next considered, in which the same law holds good, that a number of small bars will sustain a greater weight upon them than one large bar having the sum of the areas of all the small ones in its section. In calculating the strength of a large bar from trials upon smaller ones, this effect must therefore be allowed for, and most probably arises from the greater facility of working, preparing, or hammering the smaller bars. The processes of faggotting or uniting several small bars of iron together by welding to remedy this inconvenience, and of wire drawing, were here shewn and explained; some practical deductions from the use of iron cables, and iron ropes for the shafts of mines were also noticed, by which it appears a most material saving of

expense with equal strength is attendant upon the iron chains. Professor Robison's tables of the tenacity of the various metals were adverted to and exhibited, by which it appears that bar steel is to beat iron as 135 is to 70. That among the mixed metals, 6 parts of copper and 1 of tin, an alloy called gun metal, is the most tenacious, and next to this, 5 parts of gold and one of copper.

As the operations of flatting or rolling the metals into thin plates, depend upon the plastic qualities of the metals so treated, the processes of milling lead and copper, or forming them into sheets for covering buildings, and of drawing or producing lead, copper, brass, and other tubes or pipes, together with the machinery by which such processes are carried on, became objects of explanation in this place.

The ability of bodies to support weights not acting perpendicularly upon, or under them, was next investigated, and the nature of these levers which are formed or exist to produce a fracture in a beam supported at one or both ends, as well as the best forms of these for strength. The value of the parabolic curve was here pointed out in this respect, and its application shewn in the construction of steam engine beams, the Eddystone lighthouse and other examples. The advantages of cast iron or other hollow tubes for supporters, and the best and most œconomical means of using cast iron in beams, supporters, connecting rods, &c. was shewn and demonstrated to be either in the tubular form, or that which is technically called *feathered*, i. e. two thin plates laid at right angles to each other, so that their transverse section may present a cross (thus +).

Next to the examination of materials in their simple or uncombined state, came that of combination, or uniting them into various forms. The rationale of fixing cantilevers into walls to support galleries, the construction of what are called geometrical staircases, the precautions which ought to be used in securing the audience parts of public theatres, and the construction of roofs to obtain the greatest possible strength with the least weight and consumption of materials, were all treated at considerable length, and the principles illustrated

by models constructed for the express purpose, as well as by numerous drawings and engravings of roofs which have been executed upon a number of churches, theatres, and other large buildings, not omitting several which are entirely of iron, a material which we believe was first appropriated to this purpose by those highly eminent artists, Messrs. Watt and Boulton, of Birmingham, but which has since been in common use. The Grand Junction water works engine house at Paddington, is among the most light and elegant examples of this kind near London. The methods of uniting timbers or other materials by mortices and tenons, of trussing beams to obtain additional strength, and of framing and bracing so as to obtain stability, and the principles upon which these depended, were fully detailed. The method of trussing beams with pieces of feathered cast iron, instead of oak, as commonly used, was believed, by Mr. Millington, to have been first adopted by himself, in his practice, and its many advantages were fully explained.

The theory and important uses of the arch were next introduced, with some historical observations on the changes which its form had undergone at different periods; and after explaining the nature of the catenarian curve, or that formed in all positions by a chain suspended at its two ends only, and the researches of Galileo, Bernouilli, Dr. David Gregory, and others, who endeavoured to demonstrate that it was the strongest and best form for the arch, the reasoning of Dr. Hutton and Atwood was examined and adopted, and the nature of an arch of equilibration, or one in which all its parts are in such adjustment to each other as to produce the nearest approach to equilibrium, was shewn and approved. This by no means confines the taste of the artist who designs it, since the curve may be varied in any manner, provided the parts which compose it are properly adjusted to each other, and for which simple formulæ and tables will be found in Dr. Hutton's very elegant little treatise on the principles of bridges. The nearest approach to an arch of this description at London will shortly be seen in the magnificent cast iron bridge now erecting over the River Thames at the bottom of Queen-

street, by John Rennie, Esq. and to be called the Southwark Bridge. This bridge will consist of only three arches, being segments of circles. The middle arch has a rise, or versed sine of only 24 feet, while its span is 240 feet. It is to be composed of 8 ribs or bars of cast iron, united by diagonal braces, each principal rib being 6 feet deep at the crown or top of the arch, and gradually extending to 8 feet in depth at the abutments, or parts which rest upon the stone, which is to be from Craig Leith,. the piers being of granite; the whole of this magnificent edifice has been cast at the extensive iron works of Messrs. Walker and Co. at Rotherham in Yorkshire, and each piece, as it is completed, is there built, and put together into arches, before it is shipped for London, consequently, when the piers, centering, and other preparations are in readiness, this superb ornament to the metropolis will proceed with a rapidity which must appear astonishing.

The elliptic arch not only has the advantage of admitting a more level road when used for bridges, but will cover or extend over the same space with a much less quantity of material than a semi-circular one, being as the radius of the semi-circular arch is to the semi-conjugate diameter of the ellipse, which can be inscribed within it. This form of arch has been selected by Mr. Rennie in the construction of that magnificent structure the Waterloo Bridge, the roadway over which is a dead level, of 1240 feet long within the abutments, and 42 feet wide within the ballustrades; it consists of nine equal arches, each of 120 feet span, while the thickness of each pier is but 20 feet, leaving a clear water way of 1080 feet. Mr. Rennie has been particularly happy in the choice of his materials, having selected primitive rock for the whole exterior of this bridge, instead of the secondary and more perishable materials, such as free stone, which are too frequently resorted to. The whole is built with Cornish granite, except the ballustrade, which is of granite from Aberdeen. Mr. Millington here entered into a minute and particular account of the manner of proceeding in building under water, taking the operations which had been performed in the construction of this bridge as an

example. The nature of the coffer dams, or inclosures of piles, by which the bottom of the river was laid dry, to get in the foundations of the piers—the driving a long pile in every yard square, to form the foundation—the engines for driving the piles and pumping out the water, were all described, and contrasted with the plan of using floating caissoons, which were adopted by Mr. Baldwin in the construction of Westminster Bridge, respecting the building of which, as well as that of Blackfriars, all the leading particulars were recounted, and the construction of these bridges contrasted, with that of some of the most eminent and curious in different parts of the world; among which were, the Wooden Bridge at Terrebonne, near Montreal, in North America—the Bridge of Schaufhausen, in Switzerland—the Pont de Neuilly, at Paris, and the remarkable arch at Pontyprid, over the Taaffe, in Wales.—Several drawings of the timber centering upon which arches must be built in the first instance, were produced, and that constructed and used by Mr. Rennie for the Waterloo Bridge, was much admired and commended, as depending upon the longitudinal incompressibility of timber, so that, although it was only supported at its two extreme ends, 120 feet asunder, its yielding to the pressure of the stones placed upon it before the key stone was fixed, was hardly perceptible; and as a proof of the solidity with which the masonry was constructed, upon striking or removing the centres, the arches only sunk about an inch, while those of the Pont de Neuilly are said to have fallen above a foot. The modes of striking centres both in this bridge and others, were also shewn and explained by models, and the present improved system of bridge building, was compared with that which formerly existed, and illustrated by an account of the ancient Bridge of London, examined both in its former and present state. In this the piers are from 25 to 34 feet in thickness, and the total width of the river, which upon its site is 900 feet, is reduced to 450 feet, or one half in water way; so that, notwithstanding the former centre pier was pulled down, and the two centre arches thrown into the one more modern arch which now exists, still half the river is blocked up with useless masonry and timber

work, as well as an immense quantity of stone and chalk which are annually put down to preserve the foundations, which, according to the plans that have been taken of them, are in a very dilapidated state, which helps to produce that detrimental and dangerous torrent of water that is constantly experienced with the running out of the tide. A sketch of a bridge without arches, but upon the principle of the trussed roof, with king and queen posts, having the interstices filled up with Gothic fret work, was exhibited as the same was proposed to be erected in cast iron, by Mr. Ralph Dodd, in lieu of the present London Bridge; but it was presumed that this was on too large a scale to admit the possibility of its ever being carried into effect, since the openings, which were to be but three in number, were to be 300 feet wide each, and its elevation such as to permit an Indiaman in full sail to pass underneath it; the consequence of such elevation would, however be, that the inclined planes or approaches would extend to at least 500 feet on each side of the river, and at such an height that they would pass over the tops of the houses adjacent to the river.*

This account of bridge building was succeeded by a short description of the construction of tunnels or arched passages made under-ground, and the nature of groined and mitred arches, as well as the tunnels of timber used in coal and other mines; the illustrations being chiefly taken from the Highgate Tunnel, which fell in; the attempt at forming tunnels under the bed of the Thames at Gravesend and Rotherhithe, and some of the tunnels which have been constructed on the line of the Grand Junction Canal; the mode of proceeding and probable reasons of failure in the former attempts being pointed out; and this part of the subject was concluded by a few observations on hemispherical arches or domes, the prin-

* Mr. Dodd exhibited a beautiful model of this bridge at the last exhibition of the Royal Academy in Somerset Place. It was in the sculpture room, and had several houses, and an Indiaman, drawn to scale, placed underneath it.

ciples of which were pointed out, and their difference of construction illustrated, by the massive and stupendous dome of the Pantheon at Rome, which is built entirely of stones, contrasted with the light, elegant, and scientifically constructed dome of St. Paul's Cathedral, which reflects high credit upon its eminent projector.

The strength and power of materials, and methods of uniting them to the best advantage, for the support of weight in a passive state, having been so far discussed, the nature and varieties of motion, as it applies to machinery, and that of mechanic power, became the next objects of inquiry. Motion in whatever state it exists, implies a power to produce it, for all matter being naturally inert and motionless, cannot begin to move without some disturbing cause. Gravitation being general, and at all times existing, may be considered as the most common and universal agent of this kind, and therefore was first taken into account. The laws of falling bodies, and the properties of simple motion, and its rectilineal direction, were here shewn and demonstrated, and likewise that no idea could be formed of motion, but by the existence of more bodies than one, by which a comparison could be made. The nature of positive and relative motion were also pointed out, as well as the acceleration which falling bodies experience.—The composition of motion, arising from its being produced by more causes than one acting at the same time, was also illustrated, as well as that motion and matter, under different velocities and quantities, may be made to balance each other under all circumstance, by the momentum or force acquired by moving, being regulated according to the quantity of resistance which is to be overcome.—The operation of the mechanic powers, which before had only been explained as to their effects, were now shewn to depend upon these principles of motion for their action, and, consequently, what is generally considered as gaining a mechanical advantage, or lifting a weight with a power less than that by which it gravitates, is, in fact, nothing more than substituting a velocity different from that with which it would move, if it were moved at the extreme of its gravitating power, and from these

principles the universal and unerring law of mechanics was clearly adduced, established, and proved, by many examples, that the power applied, and velocity with which the resistance moves, must be in a constant ratio to each other, and cannot possibly be altered or varied by any different disposition of parts of a machine, as many unacquainted with this principle vainly hope and suppose, and from a want of which knowledge much labour and expense have been incurred, by the ignorant, in attempting to produce perpetual motions, and other machines equally astonishing, but which reach no further towards perfection than to torment their disappointed projectors.

The application of the several mechanic powers to the production of those motions to which they are best adapted, was next examined at considerable length. The lever being only capable of producing a reciprocating motion for a short distance, while the wheel and axle will produce a continued circular motion for any given length of time, and will communicate its motion to other wheels and axles, either by cords or bands, passing in grooves upon their edges if they are at a distance from each other; or by teeth or cogs upon those edges, if they are in contact; and hence arises the construction of that wheel-work which is used in clocks, watches, and orreries, and on a large scale in mills and various machines for manufacturing purposes. As the teeth of wheels cannot move into each other without considerable friction, it has long been a desideratum among mechanics, to determine mathematically, the curve or form they should have, to produce the most steady and equable motion, with the least possible friction, and simple as this position may seem, yet it is by no means clearly ascertained, some recommending the cycloidal form, others the epicycloidal, and others again, the involute of the circle. The nature of these several curves were therefore laid before the audience, together with the reasoning upon them, by Camus, Emmerson, Professor Robison, Buchanan, and others. The involute of the circle is supported by Robison, and appears to possess advantages; but Mr. Millington stated, from his own experience, that the epicycloidal

tooth was found to work extremely well in mill-work, with circular wheels, though he preferred the involute of the circle, whenever a circular wheel worked into a straight edge, or toothed rack, as it is technically called. In all cases, it is desirable to make the teeth as small as the strength of the work will admit of, as by this means, the motion is rendered much more pleasant and equable, and the shake and friction are reduced. The different forms of wheels were noticed, and particularly the ingenious contrivance of the late Mr. James Ferguson, of placing the teeth within the circumference of the edge, instead of without it, by means of which, motion may be continued in the same direction, by two wheels only, which in all other cases, require three, since any two wheels in contact with each other, but otherwise disposed, will always move in contrary directions.

The pulley, either in its simple or combined state, is only capable of producing rectilineal motion; it is, however, very useful in changing the direction of a force, as when motion is required at right angles to the power which produces it: and in its compound state, from the quantity of cord which it winds up or consumes, and which will always be in proportion to the power it gains, it is highly useful in prolonging the action of descending weights, when employed as prime mover; and for this reason, it is generally so applied to clocks, roasting jacks, and other small machines moved by a descending weight. The inclined plane and the wedge, produce motion, by a process completely distinct from those powers before described, namely, by their own solidity being introduced between any fixed body and that which is to move; whence it follows, that the motion they can produce, must be very small, and can, in no case, exceed the thickness of the body employed to produce it; and as this is attended with a considerable degree of friction, these powers are much less resorted to in practice than any of the others.

The screw, though partaking of the nature of the two last, is much more frequently made use of in machines, and although it cannot produce a motion exceeding its own length, where it moves with the body, yet, when fixed in that form,

commonly called an endless screw, it will communicate continuous motion to a wheel acting into it. It is of important use in the accurate division of astronomical instruments, and when used in the form described by Mr. Hunter, in the Phil. Trans. vol. 71, produces the most gradual motion which can be conceived. The manner of forming screws with the necessary tools and implements, was here shewn and explained.

The varieties of motion which are necessary in the construction of mechanical engines were next enumerated and arranged, and several beautiful contrivances described, by which these varieties are produced. The simple Crank, Fitzgerald's, and Armstrong's machines, from the Society of Arts, the parallel motion apparatus applied to steam engines, by Boulton and Watt, and by Fenton, Murray, and Co. of Leeds—Dr. Hook's universal joint, and Baker's patent mangle apparatus, were among this number, but being already before the public, though perhaps not sufficiently appreciated, they need not be described in this place.

Since weight was necessarily referred to as the standard of mechanic power, in all the foregoing investigations, it became necessary in this place, to make some further observations on its nature and qualities, and accordingly, this division of the subject was concluded by the experiments and deductions which are detailed by Mr. Smeaton, in his paper on this subject, printed in the Phil. Trans. for 1776, and followed up by others, on the difficulty of obtaining a standard of weight and measures, a subject which has engaged the attention of mathematicians for a considerable number of years. The difficulties attending the solution of this apparently simple and important problem were explained; as gravitation or weight, depends upon the quantity of matter which can only be identified by bulk or dimensions, as weight was shewn to be a relative term, which requires magnitude to determine its value, and consequently, as weights must depend upon measures, so a standard of measure is all which needs to be determined. Unfortunately, however, it happens, that such standard must possess powers which are the most

difficult of attainment. It must be immutable, incapable of wear, and of easy access to every one, that they may renew their standard, should it at any time be lost; and after all the investigations which have taken place on this subject, only two objects seem to offer a reasonable hope of being able to succeed, though both these are surrounded with difficulties which have not yet been overcome. The first is the measurement of an arc of a meridian upon the earth's surface, which, from the extent of the operation, must be subject to casualties, however carefully conducted, and the other is derived from the pendulum, making a certain given number of vibrations at a given length in a sidereal day, since, if the length of the pendulum varies, the number of its vibrations will vary also, and as this is a simple instrument, and may be daily corrected, it deserves the most serious attention, and seems to offer the most flattering hopes of success, though, unfortunately, the same pendulum will not vibrate with the same velocity, in different latitudes, and is attended with other difficulties which have not yet been surmounted.

The Courses of Chemical Lectures and Demonstrations delivered in the laboratory of the Royal Institution by Professor Brande, will commence on Tuesday the 7th of October, punctually at nine in the morning, and will be continued at the same hour on Tuesdays, Thursdays, and Saturdays through- the season.

A text book, for the use of the students, containing the principal facts of chemical philosophy arranged in the order in which they are discussed, and illustrated in these lectures, will shortly be published.

The subjects comprehended in the courses are treated of in the following order.

Division I. *Of the Powers and Properties of Matter, and the general Laws of chemical Changes.*

§ 1. Attraction—Crystallization—Chemical affinity—Laws of Combination and Decomposition.

§ 2. Light and Heat—Their influence as Chemical Agents in art and nature.

§ 3. Electricity—Its Laws and connexion with Chemical phenomena.

Division II. *Of undecompounded Substances and their mutual Combinations.*

§ 1. Substances that support Combustion, Oxygen. Chlorine, Iodine.

§ 2. Inflammable and acidifiable Substances—Hydrogen—Nitrogen—Sulphur—Phosphorus—Carbon—Boron.

§ 3. Metals and their Combinations with the various Substances described in the earlier part of the Course.

Division III. *Vegetable Chemistry.*

§ 1. Chemical Physiology of Vegetables.

§ 2. Modes of Analysis—Ultimate and proximate Elements.

§ 3. Processes of Fermentation and their products.

Division IV. *Chemistry of the Animal Kingdom.*

§ 1. General views connected with this department of the Science.

§ 2. Composition and Properties of the Solids and Fluids of Animals—Products of Disease.

§ 3. Animal Functions.

Division V. *Geology.*

§ 1 Primitive and secondary Rocks—Structure and situation of Veins.

§ 2. Decay of Rocks—Production of Soils—Their analysis and principles of Agricultural improvement.

§ 3. Mineral Waters—Methods of ascertaining their contents by Tests and by Analysis.

§ 4. Volcanic Rocks—Phenomena and Products of Volcanic eruptions.

In the First Division of each Course, the principles and objects of Chemical Science, and the general Laws of Chemical Changes are explained, and the phenomena of Attraction,

and of Light, Heat, and Electricity developed, and illustrated by numerous experiments.

In the Second Division, the undecompounded bodies are examined, and the modes of procuring them in a pure form, and of ascertaining their chemical characters exhibited upon an extended scale.—The Lectures on the Metals include a succinct account of Mineralogy, and of the methods of analysing and assaying Ores.

This part of the Courses will also contain a full examination of Pharmaceutical Chemistry; the Chemical Processes of the Pharmacopœiæ will be particularly described, and compared with those adopted by the Manufacturer.

The Third and Fourth Divisions relate to Organic Substances.—The Chemical changes induced by Vegetation are here inquired into; the principles of Vegetables, the Theory of Fermentation, and the character of its products are then examined.

The Chemical History of Animals is the next object of inquiry—it is illustrated by an examination of their component parts, in health, and in disease; by an inquiry into the Chemistry of the Animal Functions, and into the application of Chemical principles to the treatment of Diseases.

The Courses conclude with an Account of the Structure of the Earth, of the changes which it is undergoing, of the objects and uses of Geology, and of the principles of Agricultural Chemistry.

The applications of Chemistry to the Arts and Manufactures, and to œconomical purposes, are discussed at some length in various parts of the Courses; and the most important of them are experimentally exhibited.

Further particulars may be obtained by applying to Mr. Brande, or to Mr. Fincher, at the Royal Institution, 21, Albemarle-street.

Art. XV. *Dr.* Ure *on Mean Specific Gravity.*

Glasgow, September 20th, 1817.

Sir,—In Table III. of my memoir on sulphuric acid, I have shewn the false results obtained, by supposing the *mean* specific gravity of a mixture,* to be the arithmetical mean of the specific gravities of its components. Now since it is an opinion, currently received among many chemists, and one which has given rise to very serious errors, that the half sum, or arithmetical mean of two numbers, representing the specific gravities of two bodies, combined in equal weights, gives the true calculated mean of their specific gravities, I hope the following demonstration of its falsehood will be useful.

An opposite example will be found, in Aikin's Chemical Dictionary, article Alloy, from which the following passage is taken. " If, therefore, we melt together, equal weights of copper wire of the specific gravity 8.87, and laminated gold sp. gr. 19.36, and find that the specific gravity of the button of alloy, instead of being equal to 14.11" $\left(=\frac{8.87+19.3}{2}\right)$ " is considerably less than the mean of its component parts, we shall yet by no means be justified, in inferring from this fact, that chemical union has taken place. The specific gravity of copper slowly cooled, and not wire drawn, is only 7.78, and that of gold in the same circumstances, is 19.25, and this being also the state of the alloy, its calculated specific gravity, instead of being 14.11, ought to be estimated only at 13.51"

$$=\frac{7.78+19.25}{2}.$$

Now both these estimates are false, for 14.11 is not the calculated sp. gr. of the first, nor 13.51 that of the second mixture; and since such erroneous doctrines or examples, are held forth in a work of very great merit, it becomes an indispensable duty to correct them.

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* I do not mean the specific gravity by experiments, which may be greater or less than the other, according as the chemical union is attended with condensation or expansion.

The specific gravity of one body, is to that of another, as the weight of the first, divided by its volume, is to the weight of the second, divided by its volume; and the mean specific gravity of the two, is found, by dividing the sum of the weights by the sum of the volumes.

Let W, w, be the two weights; V, v, the two volumes; Pp, the two specific gravities; and M, the calculated mean specific gravity. Then

$M = \frac{W+w}{V+v}$; the formula by which I computed the second column of Table II.

$$\text{And } V + v = \frac{W}{P} + \frac{w}{p} = \frac{Wp + wP}{Pp}$$

$$\text{Hence } \frac{W + w}{V + v} = \frac{W + w}{\frac{Wp+wP}{Pp}} = \frac{(W+w)Pp}{Pw + pW} = M$$

For the laminated gold and the copper wire, M, or the true calculated mean density, is 12.16; very different from the arithmetical mean 14.11; and for the soft metals, it is 11.06; still more remote, from 13.51, as given by Messrs. Aiken. Since it is the erroneous mode of computation which we are exposing, it is of no consequence, whether we call soft copper 7.78, as in the dictionary, or 8.78, as it should be.

Thus, also, gold and silver give for their arithmetical mean density, $\frac{19.3 + 10.5}{2} = 14.9$. Whereas M, or the calculated mean density is only 13.6.

And lead and tin, give $\frac{11.3 + 7.3}{2} = 9.3$; while M is only 8.87.

Hence we see, that when the difference in density, between the two substances is considerable, as it is with sulphuric acid and water, the errors produced by assuming the arithmetical mean, for the true calculated mean, are excessive. If we take copper and tin, however, then the arithmetical mean, $\frac{8.89 + 7.29}{2} = 8.09$, differs very little from 8.01, the accurate mean density.

By a similar error, I suppose, in calculating the mean density of liquid muriatic acid in its different stages of dilution, the celebrated Kirwan has long misled the chemical world. He asserted, that the mean specific gravity of the components, being also the experimental mean, there is no condensation of volumes, as with other acid dilutions. And the illustrious Berthollet has even assigned a cause for this suppositious fact. I find, on the contrary, that 50 of acid, sp. gr. 1.1920 with 50 of water, give out heat, and we have their volume diminished in the ratio of 100 to 99.28. The experimental specific gravity is 1.0954; that, by the exact rule, is only 1.0875.

To demonstrate the error of the common method, we may observe, that $\frac{W+w}{V+v}$ is the real value of the specific gravity of the mixture; and $\frac{W}{2V}+\frac{w}{2v}$, is the mean value commonly supposed for the specific gravity of the mixture.

Let Δ, be the difference between the former, and the latter value, which gives $\frac{W+w}{V+v}=\frac{1}{2}\left(\frac{W}{V}+\frac{w}{v}\right)+\Delta$

$$\text{or } \frac{2\frac{W}{V}.V+2\frac{w}{v}.v}{V+v}=\frac{W}{V}+\frac{w}{v}+2\Delta$$

Reducing the second member of this equation to the same denominator, as the first, in order to obtain the value of 2Δ, we have

$$2\Delta=\frac{2\frac{W}{V}.V+2\frac{w}{v}.v-\frac{W}{V}.V-\frac{w}{v}.V-\frac{W}{V}.v-\frac{w}{v}.v}{V+v}$$

and reducing the terms which destroy each other, we have $2\Delta=\left(\frac{W}{V}-\frac{w}{v}\right)\frac{V-v}{V+v}$, a formula of remarkable simplicity.

We may observe that the value of $\Delta=\frac{1}{2}\left(\frac{W}{V}-\frac{w}{v}\right)\frac{V-v}{V+v}$, can become null only in two cases:

1st. When $\frac{W}{V}-\frac{w}{v}=o$; or $\frac{W}{V}=\frac{w}{v}$; that is to say, when the specific gravities are equal.

2d. When $V - v = o$; or $V = v$; namely, when the volumes are equal. Consequently, when neither the specific gravities, nor the volumes of the components are the same, the ordinary method, or arithmetical mean will be false, and the error Δ which it will produce will be greater,— 1st. In proportion as the difference of the specific gravity $\frac{W}{V} - \frac{n}{v}$ are greater; and 2d, as the difference of the volumes $V - v$ shall be greater.

The preceding formula may be presented, under a still more convenient form. P, p being the specific gravities of the two components, we have as above $P = \frac{W}{V}$ and $p = \frac{w}{v}$; whence $V = \frac{W}{P}$, $v = \frac{w}{p}$.

In the condition when $W = w = 1$, we have then

$V = \frac{1}{P}$, $v = \frac{1}{p}$, and consequently therefore

$$2\Delta = (P - p) \times \frac{\frac{1}{P} - \frac{1}{p}}{\frac{1}{P} + \frac{1}{p}} = \frac{(P-p)(p-P)}{P+p} = -\frac{(P-p)^2}{P+p}$$

This value being constantly negative, proves that the true value of the specific gravity of the mixture, represented by $\frac{W+w}{V+v}$, is always smaller, than the false value, $\frac{1}{2}\left(\frac{W}{V} + \frac{w}{v}\right)$.

Example of the last formula,

Gold and silver, $\frac{19.3 + 10.5}{2} = 14.9$ = false or arithmetical mean of specific gravity.

$\frac{(P-p)^2}{P+p} = \frac{(19.3-10.5)^2}{29.8} = \frac{(8.8)^2}{29.8} = \frac{77.44}{29.8} = 2.6 = 2\Delta$; and $\Delta = 1.3$, which being subtracted from the arithmetical mean 14.9, leaves 13.6 for the true mean specific gravity as directly obtained by the formula $\frac{(W+w)\,Pp)}{Pw + pW}$.

Art. XVI. *Miscellanea.*

I. *Optical Structure of Ice.*

We understand that Dr. Brewster, when examining the optical properties of ice, has found that even large masses two or three inches thick, formed upon the surface of standing water, are as perfectly crystallized as rock crystal, or calcareous spar, all the axes of the elementary crystals corresponding with the axes of the hexaedral prisms, being exactly parallel to each other, and perpendicular to the horizontal surface. This unexpected result was obtained by transmitting polarised light through a plate of ice, in a direction perpendicular to its surface. A series of beautiful concentric coloured rings with a dark rectangular cross passing through their centre were thus exhibited, and were of the opposite nature to those which Dr. Brewster had some years ago discovered in beryl, the ruby, and other minerals. The polarising force of ice was found, from many experiments, to be $\frac{1}{2117}$, that of rock crystal being $\frac{1}{360}$.

II. *Combustion of the Diamond.*

Sir Humphry Davy was the first to shew that the diamond was capable of supporting its own combustion in oxygen, without the continued application of extraneous heat, and he thus obviated one of the anomalies exhibited by this body, when compared with charcoal. This phenomenon, though rarely observed, is easily exhibited. If the diamond, supported in the perforated cup, be fixed at the end of a jet, so that a stream of hydrogen can be thrown on to it, it is easy, by inflaming the jet, to heat the gem, and whilst in that state to introduce it into a globe or flask containing oxygen. On turning off the hydrogen, the diamond enters into combustion, and will remain burning until nearly consumed. The loss of weight in the diamond, the formation of carbonic acid, and the actual combustion, are thus very easily shewn.

III. *To the Editor of the Journal of Science and the Arts.*

Sir.—To guard against any misapprehension which might arise from a perusal of the note at p. 297 of the last Number of the Journal of Science and the Arts, I request your insertion of the following statement. The author of *the Elements of Pathology and Therapeutics* has never, by any means, direct or indirect, been made acquainted with the opinions of Dr. Park, till long after the publication of his own work. In the course of 1816, he was presented by Dr. Park with a copy of his " Enquiry," which, on its arrival, he gave into the hands of your present correspondent, desiring his perusal and opinion of it, but Dr. Parry's lamented illness, which happened soon after, prevented a further attention to the subject.

If the establishment of priority of claim to a philosophical opinion were of real importance to the advancement of scientific truth, it might be easily shewn that all the leading principles, maintained in the above-mentioned work, have been recorded in print, or in writing, and have been in general circulation, through the author's extensive correspondence, for more than twenty-five years, as the basis of his medical practice during that period.

Whatever accidental coincidence may be found to exist on the points to which allusion has been made, it seems equitable to state thus much in defence of an author, whose only plagiarisms have been from the common volume of nature, which he has long and anxiously studied, and whose enquiries are unhappily interrupted by continued and severe indisposition.

I remain, Sir, yours, &c.

Bath, August 12, 1817. CHARLES H. PARRY.

Dr. Park feels obliged by the Editor's communication of Dr. Parry's letter, as it gives him the first intimation of the book having been received, which he took the liberty of presenting to Dr. Parry on the perusal of his late publication, being struck with the coincidence between them.

Southampton-street, August 20, 1817.

IV. *Mode of ascertaining the comparative Value of each Cow's Milk in a Dairy. (From the Farmer's Journal) alluded to in our last Number.*

Lincolnshire, August 26, 1816.

SIR,

I HAVE not observed that the valuable improvement communicated to the Oxfordshire Agricultural Society by their worthy President, Mr. Fane, of a method of ascertaining the comparative value of the milk of each cow in a dairy, has yet found its way into your paper. I trouble you with this to state the manner in which I have availed myself of it, with the complete approbation of my wife, her housekeeper, and her dairy-maid.

The principle of the invention is, that if milk is poured into a glass and suffered to remain, the division between the cream that swims upon it, and the milk below, will be so plain and evident, that the depth of the cream may be easily measured; of course if the milk of any cow produces more cream than that of another, the difference may be correctly ascertained; this may be done in any glass vessel having upright sides: a tumbler, for instance, or, what is better, one of those glasses in which shopkeepers preserve their sugar plums and such like wares. If the depth of milk poured into a glass, be exactly 6 inches and 2-8ths, every 1-8th of an inch in depth of the cream swimming upon it, will be equal to 2 per cent. of the amount of the whole of the milk.

The apparatus I use consists of tubes of glass about ½ an inch in diameter, and about 11 inches long, fixed upright in a wooden frame, each tube having a line round it marked by the glassman exactly 10 inches from the bottom. At milking time each tube is filled up to the line with the milk of a cow; after standing 12 hours the cream which floats upon the milk is measured by a scale of 10 parts to an inch, as the whole depth of the milk and cream is 10 inches, each division will represent one per cent. of the whole; of course, if the milk given by a cow at a meal is one gallon, or 8 pints, and the thickness of the cream that floats upon it measures 14 divisions, multiply the number of pints of milk (8,) by the depth of the cream, 14 divisions, and the result will be, that the produce of the cream of that meal is 112, or

one pint $\frac{12}{100}$. These tubes may be bought of Mr. Newman, in Lisle Street, Leicester Fields, for 9d. each. Care must be taken to fill the tube as soon as the pail is taken from under the cow, for if any delay takes place, some of the cream will have ascended towards the top. The milk should be taken from the middle of the pail, and poured into the tube without froth, which is done by dipping a cream pot below the froth and filling the tube from thence, after having struck off the froth with the blade of a knife.

Rich milk is not white but brown, as is evident by comparing the milk of different cows when in the glass tubes; by the colour of the milk a tolerable estimate may be made of its produce in cream. The richness of the cream may also be estimated by the colour of the cream floating on the tubes. The best Alderney cream has a yellow hue, almost as deep as the flower of the buttercup, while the cream of a Holderness cow fed upon sour grains is as white as chalk, as the cream separates itself. Rich milk first becomes white, and then takes a blueish hue.

Every dairy woman knows that the first milkings of a cow are almost without cream, and that the last pint or half pint which is drawn from the udder with difficulty, is almost entirely cream, hence the necessity of filling the tube from the whole of the milk yielded by a cow; and it may not be an improper caution to stir it about with a spoon to mix the cream and milk more regularly together, before the tube is filled.

It is proper to observe, that the quantity of cream that floats upon the milk in Mr. Fane's glasses, can not be obtained by the present imperfect method of setting milk in shallow vessels, and taking off the cream by skimming; the whole quantity may be gotten by setting the milk in deeper vessels, and drawing it from under the cream by a syphon; it is evident from this, that the present system of managing our dairies is capable of much improvement.

Your humble servant, &c. H. S.

V. *Effects of Inhaling the Vapour of sulphuric Ether.*

WHEN the vapour of ether mixed with common air is inhaled, it produces effects very similar to those occasioned by nitrous oxide. A convenient mode of ascertaining the effect is obtained

by introducing a tube into the upper part of a bottle containing ether, and breathing through it; a stimulating effect is at first perceived at the epiglottis, but soon becomes very much diminished, a sensation of fulness is then generally felt in the head, and a succession of effects similar to those produced by nitrous oxide. By lowering the tube into the bottle, more of the ether is inhaled at each inspiration, the effect takes place more rapidly, and the sensations are more perfect in their resemblance to those of the gas.

In trying the effects of the ethereal vapour on persons who are peculiarly affected by nitrous oxide, the similarity of sensation produced was very unexpectedly found to have place. One person who always feels a depression of spirits on inhaling the gas, had sensation of a similar kind produced by inhaling the vapour.

It is necessary to use caution in making experiments of this kind. By the imprudent inspiration of ether, a gentleman was thrown into a very lethargic state, which continued with occasional periods of intermission for more than 30 hours, and a great depression of spirits; for many days the pulse was so much lowered that considerable fears were entertained for his life.

VI. *Process of M. Robiquet for the Preparation of Morphium.*

[From the Annales de Chimie.]

A CONCENTRATED infusion of opium is to be boiled with a small quantity of common magnesia for a quarter of an hour. A grayish deposit in considerable quantities is formed: this is to be filtered and washed with cold water, and when dry acted on by weak alcohol for some time at a temperature beneath ebullition. In this way very little morphium, but a great quantity of colouring matter is separated. The solid matter is then to be filtered, washed with a little cold alcohol, and afterwards boiled with a greater quantity of highly rectified alcohol; it is to be filtered whilst hot, and the spirit on cooling deposits the morphium in crystals, and very little coloured. This is to be repeated three or four times with the residuum, and the morphium obtained by each filtration is less and less coloured.

VII. *Extract from a Paper on the North of Ireland, read before the Wernerian Natural History Society of Edinburgh. By* H. M. Da Costa, M. D.

I am induced to suppress the descriptive part of this paper, read before the Wernerian Society last year, by the publication of an admirable paper on the same subject in the Geological Transactions, and to content myself with giving my testimony from ocular demonstration, to its great merits. As the following arrangement of the strata in Red Bay, near Cushendall, is not noticed, I venture to add it, with the analysis of the minerals, in the subjoined extract. The lowermost visible or 1st bed, is conglomerate, composed of fragments of *primary rocks*

2 ——— a thin bed of red sandstone.
3 ——— *sandstone* conglomerate
4 ——— gray sandstone
5 ——— trap tuff
6 ——— or uppermost, sandstone conglomerate, containing much mica.

These strata are all intersected by a vein of basalt, containing in some parts so many apparent fragments as to have the characters of trap tuff; the gray sandstone is indurated, and exhibits so many varieties of stratification when in contact with the vein, as to appear shivered and broken up by it; but the other strata are not in the least affected.

As I am not aware of any analysis of iron clay, or Wacke, having been published, I subjoin one of each. The specimens I collected at the Giant's Causeway. They compose the red strata named by different mineralogists, red ochre, bole, decomposed basalt, &c.; their characters will sufficiently distinguish them.

Iron Clay.

This contains the same minerals as the basalt,* being in some places amygdaloidal.

* I collected the following minerals from the basalt:—calc. spar, arragonite, quartz, chalcedony, semi-opal—black and brown, olivin, green earth, steatite—black and variegated, analcime, chabasie, mesotype, stilbite.

External Characters.

Colour; yellowish brown to brownish red.
Lustre; none.
Fracture; small grained, uneven.
Easily frangible.
Semi Hard.
Sp. grav. 2 160

Chemical Characters.

It fuses before the blow pipe into a black slag. It does not effervesce when digested in acids.

100 grains exposed to a red heat for half an hour became so hard as to scratch glass, and lost $15\frac{1}{2}$ grs. of weight. It acquired a grayish black colour.

100 grs. in fine powder were mixed with 400 grs. of carbonate of soda; and heated for 2 hours. They coalesced into a greenish yellow mass, which was dissolved in muriatic acid and evaporated to dryness. The mass was diffused through water acidulated with muriatic acid, and the silex separated by filtration; it weighed, after ignition, 31 grains. To the filtered solution A, caustic ammonia being added, threw down alumine and oxyde of iron, which were separated from the liquor B. The alumine was redissolved in acetic acid diluted, which also took up a small portion of the oxyde of iron; to separate which it was saturated with ammonia, and set aside for 2 days, when it fell down. It was added to the portion left by the acetic acid, and weighed after ignition $25\frac{1}{4}$ grs. The alumine was precipitated by pure ammonia, and heated; it weighed 22 grains.

The liquor B, was saturated with ammonia, and oxalic acid added, which threw down a precipitate weighing, after strong ignition, $4\frac{1}{2}$ grs. Result,

Lime	$4\frac{1}{2}$
Silex	31
Alumine	22
Oxyd of iron	25
Water	15
Loss	$1\frac{1}{4}$
	100

As I could not detect magnesia or soda, it is probable that the loss arises from the state of the oxydation of the iron.

WACKE.

It does not contain any foreign matters embedded. Colour, brownish red. Fracture, fine-grained, uneven, with a tendency to conchoidal. It is dull, soft, sectile, and easily frangible. Sheall spining. Sp. grav. 2.200. It falls to powder on being moistened, which renders the difficulty of taking the sp. grav. so great, that the above numbers, though the mean of many experiments, can only be considered as an approximation.

It fuses before the blow-pipe with great difficulty.

100 grs. exposed to a red heat for half an hour lost 18½ grs. It became of a brown colour, and hard enough to scratch glass. The other steps of the analysis were the same as the iron clay.

Result.	Silex	25
	Alumine	26
	Lime	5
	Oxyd of Iron	24
	Water	18½
	Loss	1½
		100

As much stress has been laid by the advocates of the Huttonian Theory of the Earth, on the undisputed fact, that minerals are sometimes more indurated near trap rocks than at a distance from them, and as this is met by the Wernerians with the assertion, that it is not the same rock indurated, but a mineral chemically different; I have collected specimens from different quarters with a view of submitting them to the test of analysis. The following are the results of comparative examinations of the indurated limestone in contact with the basalt at the Causeway, and the common white limestone a few feet from it, but continuous with it.

Limestone in contact with the basalt.

External Characters.

Fracture: splintery. *Lustre:* glimmering. *Colour:* greenish gray. Transparent on the edges. Semi-hard. Easily frangible. Sp. grav. 2.580. To chemical reagents yields,

Silex	3
Alumine	2
Lime	47
Carbonic acid	36
Water	12
	100

Limestone a few feet from the basalt.

Extèrnal Characters.

Fracture: uneven. *Lustre:* none. *Colour:* yellowish white, not translucent. Easily frangible. Sp. grav. 2.360. It is traversed by thin veins of calcareous spar.

Results of analysis.	Silex	¾
	Lime	48
	Carbonic acid	37
	Water	12
	Alumine	2
		99¾ grs.

Art. XVII. Meteorological Diary for the Months of June, July, and August, 1817, kept at Earl Spencer's Seat at Althorp, in Northamptonshire. The Thermometer hangs in a north-eastern aspect, about five feet from the ground, and a foot from the wall.

METEOROLOGICAL DIARY

for June, 1817.

		Thermometer.		Barometer.		Wind.	
		Low.	High.	Morn.	Even.	Morn.	Even.
Sunday	1	33	62	29,70	29,67	W	W
Monday	2	38,5	61	29,67	29,57	WSW	SSW
Tuesday	3	44	61,5	29,52	29,55	WbS	SW
Wednesday	4	50	60	29,30	29,74	SW	W
Thursday	5	41	64	29,89	29,91	WbS	WSW
Friday	6	48	69	29,88	29,88	WbS	WSW
Saturday	7	56	70,5	29,80	29,68	SW	WSW
Sunday	8	51	66	29,60	29,64	W	WbS
Monday	9	46	58	29,67	29,63	SW	WbS
Tuesday	10	54	63	29,60	29,78	W	W
Wednesday	11	41	66	29,90	29,84	W	W
Thursday	12	51	63	29,66	29,60	S	WbS
Friday	13	49	59	29,20	29,56	W	W
Saturday	14	49,5	58	29,57	29,57	S	ESE
Sunday	15	44	59	30,02	30,18	W	WNW
Monday	16	34	66,5	30,20	30,13	NW	S
Tuesday	17	42	69,5	30,05	29,87	SE	ESE
Wednesday	18	47	75,5	29,70	29,60	E	E
Thursday	19	52	81	29,60	29,64	E	SW
Friday	20	53	80,5	29,70	29,69	S	SE
Saturday	21	54	81¼	29,77	29,84	NNE	EbN
Sunday	22	58,5	81	29,97	29,97	ENE	NNE
Monday	23	58	80,5	29,93	29,89	NE	EbN
Tuesday	24	57	77,5	29,84	29,81	NNE	W
Wednesday	25	56	78	29,84	29,80	W	W
Thursday	26	54	72	29,78	29,69	W	SE
Friday	27	56,5	72	29,58	29,50	NE	E
Saturday	28	57	70	29,54	29,72	W	WSW
Sunday	29	45,5	71	29,80	29,75	WSW	SSE
Monday	30	55,5	60	29,60	29,63	SW	WSW

METEOROLOGICAL DIARY

for July, 1817.

		Thermometer.		Barometer.		Wind.	
		Low.	High.	Morn.	Even.	Morn.	Even.
Tuesday	1	53	59,5	29,69	29,30	SSE	SW
Wednesday	2	54	64	29,36	29,69	W	W
Thursday	3	49	69	29,78	29,70	W	SE
Friday	4	54	67	29,50	29,47	SE	WbS
Saturday	5	52	65	29,47	29,53	NW	W
Sunday	6	50	66,5	29,56	29,57	S	W
Monday	7	51	67	29,60	29,62	WbS	W
Tuesday	8	48	66	29,70	29,73	W	W
Wednesday	9	49	67	29,75	29,74	W	W
Thursday	10	47	71,5	29,74	29,66	SE	SbW
Friday	11	50	69	29,67	29,67	SbW	WSW
Saturday	12	55	66	29,79	29,84	NE	NE
Sunday	13	49	65	29,86	29,76	S	WbS
Monday	14	51	66,5	29,59	29,49	W	W
Tuesday	15	50	63	29,13	29,22	WbS	N
Wednesday	16	45	60	29,59	29,69	NW	W
Thursday	17	48	65	29,75	29,73	W	W
Friday	18	49	60	29,73	29,79	NW	WbN
Saturday	19	48	64	29,83	29,85	W	WNW
Sunday	20	44,5	65	29,86	29,85	W	WbS
Monday	21	54	67	29,74	29,66	SW	SW
Tuesday	22	56	68,5	29,63	29,66	SW	SW
Wednesday	23	53	67	29,77	29,89	NW	NNW
Thursday	24	53,5	71	29,90	29,91	NW	SW
Friday	25	53	68	29,87	29,87	S	W
Saturday	26	52	65	29,80	29,59	W	WSW
Sunday	27	49	65	29,53	29,57	WSW	SW
Monday	28	49	66	29,68	29,74	SW	WSW
Tuesday	29	48,5	68	29,86	29,77	WbS	SSW
Wednesday	30	51	69	29,70	29,66	W	WbS
Thursday	31	48	67	29,63	29,60	W	W

METEOROLOGICAL DIARY

for August, 1817.

		Thermometer.		Barometer.		Wind.	
		Low.	High.	Morn.	Even.	Morn.	Even.
Friday	1	49	67	29,64	29,70	W	W
Saturday	2	43	69	29,80	29,82	WbS	WbS
Sunday	3	52	65	29,61	29,60	WSW	W
Monday	4	51	64	29,63	29,63	W	W
Tuesday	5	52	68	29,82	29,92	NE	NE
Wednesday	6	44	70,5	29,95	29,90	SSW	WSW
Thursday	7	43	72	29,87	29,70	SSW	SSW
Friday	8	56	63	29,44	29,50	S	W
Saturday	9	49	65	29,54	29,68	WbS	SW
Sunday	10	50	64,5	29,70	29,73	W	W
Monday	11	38	63	29,73	29,50	W	SE
Tuesday	12	49	66	29,32	29,28	SW	WSW
Wednesday	13	53	63	29,11	29,45	SW	W
Thursday	14	53,5	67	29,50	29,48	WbS	S
Friday	15	55	66	29,51	29,68	SW	W
Saturday	16	50	67	29,74	29,58	SW	SSW
Sunday	17	50	63	29,56	29,67	WbS	SW
Monday	18	46	63,5	29,79	29,70	WbS	SSW
Tuesday	19	55,5	69	29,61	29,54	WbS	SW
Wednesday	20	51	67	29,51	29,51	WbS	WSW
Thursday	21	51	60	29,63	29,85	NNW	NbW
Friday	22	40	61	29,99	30,00	NW	N
Saturday	23	35	63	29,96	29,83	NE	E
Sunday	24	50	65	29,73	29,55	E	E
Monday	25	51,5	60	29,28	29,01	E	SSW
Tuesday	26	47	60,5	29,01	28,89	SE	SE
Wednesday	27	52	64	29,01	29,22	WSW	W
Thursday	28	52	65	29,50	29,59	W	W
Friday	29	52,5	65	29,50	29,60	W	W
Saturday	30	49	65,5	29,74	29,74	W	SE
Sunday	31	53	65	29,70	29,75	SW	SW

Select List of New Publications during the last Three Months.

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THE QUARTERLY JOURNAL

OF

SCIENCE AND THE ARTS.

Art. I. *On the Construction of Prisons.*

In a Letter to the Editor of the Journal *of* Science *and the* Arts.

Sir,

In addition to the valuable information the public have received on the subject of prisons from the pen of Mr. Elmes, allow me to submit for the consideration of those interested in this branch of architecture the following general plan. It is applicable to every description of place of confinement, and has this advantage, which is indeed its characteristic, that *a prisoner may during the whole time of his imprisonment keep himself perfectly retired and unseen by any other prisoner, if he chooses.*

A prison for debtors on this principle, while it rendered the security to the public greater, would be less a place of horror and disgust to persons of elevated and delicate minds—always the most subject to misfortune. It is under these impressions that I should be happy to see the plan occupy a place in your valuable Journal.

I am, yours, &c.

J. C. LOUDON.

Bayswater House, Dec. 1, 1817.

One leading defect in almost all the prisons and penitentiaries, both in England and on the Continent, is the want of the means of a complete and constant separation of prisoners.

The pernicious effects of allowing the inhabitants of such places to associate promiscuously and indiscriminately, must be obvious in theory to every one who recollects the trite adage, " Evil communications," &c. and to have a practical illustration of its truth, we need only visit one or two of the principal prisons of this or any other metropolis. In London, for example, are annually confined some hundreds of *honest* but *unfortunate* tradesmen, a part of whom, after their penance is completed, come out fit for every vicious purpose; while those who have character enough to withstand the grosser vices and temptations of the place, too often become careless and indifferent as to the esteem of their friends and fellow-citizens, and sometimes cease to be active and industrious during the rest of their lives.

The grand object in a prison for debt is such an arrangement as shall, 1st, admit of the prisoners being *classed* according to their rank, situation in life, &c.; and 2d, as shall admit every individual to keep himself *perfectly retired if he chooses.*

In a gaol or penitentiary the desideratum is to combine *security* and *space for air and exercise,* with the means of *complete and continual separation.* The design now submitted combines these advantages more completely than any prison yet built in this country, and in execution is not more than usually expensive. As the merits which it may possess depend on the general principle of arrangement more than on particular dimensions, a concise general description shall here be attempted, previously to explaining the accompanying plates.

All the cells (speaking with reference to a gaol or penitentiary, and the rooms with reference to a prison for debtors) are placed in the circumference of a circle; and from each cell or room is a passage leading to a circular building in the centre; these *radiated passages* (as they may be called) are also the situation for air and exercise, and are constructed so as effectually to answer that purpose; *the building in the centre,* while it bears the name of *chapel,* not only serves as a place of religious instruction, but also as a school or lecture-room,

from the pulpit of which may be daily delivered lectures on subjects of art, science, or literature to prisoners for debt;—lessons on the Lancastrian plan, on the lower branches of education to paupers or prisoners confined for petty offences, and legal and moral precepts to criminal offenders. There is also an outer circumferential passage surrounding the cells, for conveying work to the prisoners, and for the task-masters inspecting them while at work. In a small prison fit for one hundred and fifty prisoners to be kept separate, there may be only one range of cells and radiated passages, all on the ground floor; in a larger there may be four or five stories of cells and passages, raising, in that case, the first range on pillars, for the sake of ventilation (as shall afterwards be described), and forming in the chapel circular passages or galleries above mentioned, answering to each range of cells or radiated passages.

The passage galleries will, in the case of penitentiaries or prisons for felons, &c. be particularly useful for the conveyance of private instruction, and at times for the delivery of food, by calling the prisoners from the cells in the circumference to the inner ends of the radiated passages (from which are gratings to the chapel gallery) and there delivering it to them. Considerable saving of time and servants may be obtained in proportion to the difference between the circumference of the circle of cells and that of the chapel. The food, which in penitentiaries ought to be chiefly soup, will be most easily conveyed in large boilers placed on wheelbarrows, and these may be wheeled up stairs on grooved iron, similar to a railway or inclined plane, and measured out hot to each prisoner. An inspector may be placed in this chapel, either to perambulate the galleries, or to inspect the whole from a balance chair, as proposed in Mr. Jeremy Bentham's plan for a Panopticon,* or

* Executed at Petersburg under the inspection of General Bentham; but being wholly composed of wood, it is not used for the purpose for which it was built, nor indeed for any purpose, so great is the dread of fire; to admit a rapid escape from which the stairs are not deemed sufficiently numerous and broad.

both methods may be used. If a number of stories of cells or passages are erected, as in the case of a prison for five hundred or six hundred persons, the necessarily narrow space that will be left between each radiated passage, together with the requisite attention to separation and security in their construction, will create some doubt as to whether those passages can be sufficiently airy for the purposes of air and exercise. To produce this, 1st. The sides of each radiated passage are of cast iron in the form of Venetian blinds, through which no object can be seen, but which admit light and air; they are 4 feet wide, and 7 feet high; the cells are 10 feet wide, and the walls 18 inches thick; hence, allowing for the thickness of the walls between the cells, and the thickness of the iron blinds, there will be a space between each radiated passage of 7 feet wide, at the end next the cells, and (as the radiated passages become narrower towards the centre) one foot at the circumference of the chapel.

2d. Whenever the prison is to be of more than one floor, the whole must be raised on pillars or arcades. Combining this circumstance with the large space between each radiated passage, and the sides of these passages being formed as of Venetian blinds, all doubts are removed as to air and ventilation.

By opening the windows in the roof of the chapel and the gratings or windows which look into it from the radiated passages, together with the doors and windows of the cells, it is evident that a powerful circulation of air would be produced in a time of the greatest calm, circulation in such cases being produced by airs of different volumes and temperatures, tending to a common temperature, &c.

Each prisoner has two cells, a sleeping room next to the radiated passage, and a work-room communicating with it, and lighted from the outer passage: this work-room in general ought to have a fire, and door to the outer passage. The fire-place is for the purpose of prisoners confined for debt, preparing their own food; and for other prisoners whose trades require the melting of metal, glue, &c. In other respects fires are unnecessary and improper, as the whole may

be heated by tubes of steam. In penitentiaries, the task masters are supposed to be continually perambulating the outer passages during working hours. In prisons for debtors, a single watchman for each floor will be sufficient. In the windows of each working cell may be a lamp or gas light, and the chapel ought to be nightly lighted in a similar manner. On a large scale there ought to be a separate prison for females—on a small scale, a separate floor, and in all cases double and treble working cells, in order to classify reformed prisoners,* or for prisoners for debt who may have families, &c. In the ground surrounding the prison there ought to be gardens for the exercise and employment of the sick and infirm, or at least yards for masons, sawyers, rope-makers, &c.†

In each radiating passage is a water cock, and water closet under it. In the construction of this building, no timber whatever need be used; and it is almost needless to add, that an elevated dry situation is preferable to one low and moist. A Governor's house, with apartments for the goalers, turnkeys, &c. the kitchen, infirmary, laundry, and other appendages, more or less necessary to every prison, as well as a number of inferior matters, do not require to be mentioned, the object in view being not to describe a complete prison, but to give *an idea of a principle capable of general application*, and of being varied to suit a most important purpose in prisons, workhouses, and every place of confinement, whether for civil, criminal, or petty offenders.

Having, I trust, conveyed a general idea of the characteristic distinctions of this plan, the accompanying Plates will be understood almost by inspection.

Plate IV. *fig.* 1. is the plan of the first story, in which

a. is the chapel in the centre.

bb. Chapel gallery.

c. Small stairs communicating with ditto, or instead of a

* As in the prisons at New York, Philadelphia. See Liancourt's *Observations on the Prisons of Philadelphia.*

† Such yards may adjoin the cells on the lower range, and may extend under the arcades supporting the whole.

stair, this may be a balance chair, as proposed by Mr. Bentham and executed at Petersburg; close by this may be seen the pulpit.

dd. Seats separated by iron plates and grated in front, with a small window in the grating, for inspection, for attending the sermons or lectures from the pulpit, to admit the reception of food, the more perfect inspection of the books of such prisoners as may be occupied in any study, &c. &c.—communications from friends, and private religious instruction, &c.

ee. passages to the cells.

f. spaces between ditto.

gg. sleeping cells.

h. working cells for two to work together.

N. B. Where offenders are to be kept quite separate, the outer cell may be the work room and the inner the bedroom, with the radiated passage leading to the chapel. In this way the prisoner may work, eat, clean himself, take air, exercise, civil and religious instruction for years together, without finding an opportunity of speaking to one of his fellow prisoners.

i. Water pipe surrounding each story, from which is a cock for each passage, &c.

k. Stairs for the ascent and descent of the prisoners, and for examining the cisterns and roof.

l. Passages for the inspectors of work, for strangers, purchasers, &c. and for occasional exercise of well behaved prisoners.

m. Principal entrance and stair-case for offices, servants, and conveying the food for the prisoners.

n. Area containing the whole, sunk 3 feet.

Fig. II. Front elevation.

a. Tower containing stairs for prisoners; the raised roof in the centre is that of the chapel.

The grated windows, those of the passages from which the exterior cells are lighted.

Fig. III. Section taken in the direction *m*, *c*, *a*, *n*, in the plan.

a. Surface of the area in which the building stands.

b. Pillars which support the whole.

c. Sewers, foundations, and other works under ground.

d. Principal staircase and entrance.

e. Radiated passages to the chapel, the under ones raised above the level of the radiated passages, in order to bring the whole of the hearers as much in view of the speaker as possible.

f. Seats for the prisoners.

g. Circular tower for the balance seat, at the bottom of which may be seen the pulpit, &c.

h. Seats for the officers in the pit and surrounding galleries.

Plate V. Fig, I. is the general elevation of a prison on this principle capable of containing 5000 persons, and enclosing 20 acres of land.

a. Entrance.

bb. Surrounding wall with 4 towers, containing alarm bells as at *bb*.

cc. A circle containing two stories, each story with a passage in the centre, and double cells on each side calculated for two and four prisoners to work together, but to sleep in separate cells, and every double working cell being on the ground floor, and leaving a garden attached to it for exercise in the manner of the radiated passages. The prisoners walk in bands to the church in the centre.

dd. Range of officers' buildings, warehouses, infirmary, &c.

ee. Prison for solitary confinement on the same plan as that delineated in Plate I. but with a larger chapel in the centre, so as to serve for the whole prison.

Fig. II. Elevation for a court of justice, supposed to be placed in a convenient situation within the general enclosure, *bb*. Fig. I.

The principal floor of this building consists of two parts; the first and principal part, which is contained under one roof, and which is seen in the elevation, contains, 1st, a vestibule and common hall of entrance and communication; 2nd, the hall of justice, or criminal court, to the right 40 by 40, and 23 high, connected with which, in the left hand end of the building, are an office for the clerk of the peace, a place of deposits for records, a private entrance, &c. On the right

from the entrance of the hall is the hall of justice, or civil court, 40 by 62 and 35 high; it is arranged on the plan of that at York, Chester, and Lancaster,

The second part of this building is behind the former, and of course is unseen in this elevation; it contains the numerous subordinate offices, such as sheriffs, clerks, officers, jury rooms, rooms for witnesses, &c. A terrace *aa.* surrounds the whole, under which, in the back front, are communications with the prison yards, for the purpose of bringing the prisoners to court, &c.

Art. II. *On the Effect of Elevation above the Level of the Sea upon the Geography of Plants in France. From the French of Mons.* De Candolle. *Paris,* 1817.

Every botanist, every traveller indeed, who has attended to plants, has been naturally led to observe them in their relations with the general, as well as local geography of the parts in which they grow; as a science, however, botanical geography is but of the other day. Linnæus had left us several tracts intended to elucidate particular points of this branch of natural history, and he has been followed by some others: but the first who appears to have been duly impressed with its magnitude and importance, was M. Giraud-Soulavie, whose Natural History of the South of France contains many very valuable and interesting observations on this head. We have also a more recent tract from the pen of M Stromeyer which, although it can only be properly termed the scheme or outline of a general work, points out the great extent to which this science is capable of being carried.

The most essential work, however, which has appeared on the subject is that of M. de Humboldt; one as pre-eminent for the number of new facts it presents, as for the judicious and successful application of them to the leading laws of natural philosophy. It is here we meet with the first chart constructed on the principle of precise measurements of elevation and degrees of temperature. Several very useful

papers upon different points of this study, have been likewise contributed by M. Ramond.

In the track of these skilful observers, I had myself submitted some general opinions regarding this department of natural history, both in the third edition of the Flore Française, and in an article of the New Agricultural Dictionary. Since then, I have devoted six years to the investigation of the different departments of France, keeping always in view, as the main object, the geography of plants. I shall in the present place, confine myself to a single point of this science, viz. the influence of elevation upon vegetation; intending to publish the general results of my observations at a future period.

As these researches have been restricted to France, it is from that country alone that I shall adduce the instances which are to serve as the groundwork of my conclusions: so that as all the instances I shall bring forward are taken from a temperate zone, and all those adduced by M. Humboldt have been drawn from between the tropics, the consequence will be, that considerable diversity between some of our results will arise out of the great difference between the fields of our respective operations. But this diversity is only in appearance: all the propositions which I adopt seem to me to coincide with those of M. de Humboldt, and even the difference in the facts of detail to be a confirmation of his general conclusions. I notice this coincidence between us at the very outset, both as tending to add weight to the observations I have made, and that I may not appear for an instant to stand in contradiction with a so highly respected associate, and honoured friend.

To analyse with precision the influence that the elevation of a spot has over its vegetation, is one of the nicest operations in geographical botany. Viewing the question in its general form, so many conflicting facts present themselves together, that it is no easy matter to draw satisfactory conclusions from them. The phenomenon itself being extremely complex, by first reducing it into separate parts we may possibly approach nearer to exactness. Elevation is in fact no simple element, like light or caloric; neither is it a medium in which

plants live, as water, air, or earth; it is a particular circumstance acting simultaneously upon all surrounding bodies, which bodies themselves possess an influence over vegetables. In this point of view it is then clear, that all the external agents which affect vegetation should be enquired into separately.

Elevation may act either directly or indirectly upon vegetation; thus we all know that it has a very decided effect upon the temperature of the atmosphere, upon the degree of solar light, and upon the surrounding moisture; now as temperature, light, and moisture have all an evident effect upon vegetables, it is clear that the action of elevation upon them in these respects, must be of the kind I call indirect. In regard to the direct action of elevation, it consists in the rarefaction of the atmospheric air, and which is known to take place in proportion as we ascend above the level of the sea. Thus it appears to me, that the true state of the question I have to discuss is this: has the rarefaction of the air, divested of all indirect influence, a sufficient action upon vegetation to affect the geography of plants? In other words, has elevation any direct share in controlling the distribution of plants? Duly apprised of the difficulties of the question, I shall endeavour to elucidate it by examining separately the agencies I have already enumerated, and by adducing in support of my views, tabular statements of the elevations of all the mountain-plants I have observed myself in France, or concerning those of which I have obtained authentic information.

§ I. *Of Elevation in respect to its Influence upon Temperature.*

We know that as we ascend in the atmosphere, the mean temperature goes on diminishing according to nearly regular laws, at this time of day tolerably familiar to naturalists; insomuch so, that allowing for local circumstances, as aspect, the action of the winds, meteorological and even solar influence, the quantity of wood and surrounding water, when once the elevation and the latitude of a place are known, its mean temperature may be pretty accurately prognosticated; now as the nature of vegetation, taken in the aggregate,

depends chiefly upon the mean temperature of every country, it is clear that it must be subject to the joint influence of elevation and latitude. And this is a conclusion which is confirmed by all the general facts relative to the geography of plants.

1st. We know that there is a great number of plants to be found only at certain elevations; but what had not been clearly noticed by any one before M. de Humboldt, is, that this steadiness in plants to their position above the level of the sea, is the more constant and evident in proportion as we advance nearer to the equator; this fact, which a comparison of the tables annexed to this tract, with the chart of M. de Humboldt, will demonstrate, this fact, I say, would be inexplicable, if the rarity of the atmosphere had an important influence over vegetation, and tends on the other hand to prove that temperature takes the principal share in the phenomenon. In reality, as the mean temperature of a place is derived from a joint agency of both latitude and elevation, the more the influence of latitude is diminished, the greater will be the proportional effect of elevation; besides, the difference of aspects to the north and to the south becomes greater, as the distance is increased from the equator; so that, in a two-fold point of view, the vegetation of a given place should be the more under the control of elevation as we come nearer to the equator. It is in this point of view that my observations, although apparently in contradiction with those made by M. de Humboldt, are, in truth, confirmations of them.

2dly, Most of the plants of France, which are found to be insensible to the effects of mean temperature, and which grow indifferently in all our latitudes, are at the same time but little affected by elevation, and grow from the brink of the ocean to the summits of our mountains. This point will be demonstrated by the fourth table, which follows the present treatise; it will be there seen that seven hundred species of wild plants in France, grow spontaneously at very disproportionate elevations. I shall only adduce a few of the most striking instances in this place.

The common heath (*Erica vulgaris*) which covers the sandy

plains that lie along the sea throughout the west of France, grows in the Pyrenees to the very summit of Mount Calm, in the department of the Arriège, at near 3,000 yards of elevation. The cross-leaved heath (*Erica Tetralix*) is another instance; it grows from the level of the sea to 2,400 yards of elevation.

I found the sea-gilliflower (*Statice Armeria*) in Holland, on spots which lay below the level of the sea, as well as while I was going up the Col du Bon-Homme in the Alps, at the height of 2,500 yards. *Statice plantaginea* grows on the beach of Olonne, and at 2,000 yards of elevation on Mount Viso.

The colt's-foot (*Tussilago Farfara*), and the bird's-foot trefoil (*Lotus corniculatus*) both grow at the level of the sea all over France, and are met with again above Mount Jovet, at the height of about 2,400 yards.

The scurvy-grass (*Cochlearia officinalis*), which is generally found at the skirts of the sea, flourishes also at the edge of the stream at Néouvielle, in the Pyrenees, at the height of about 2,000 yards.

Mother of thyme (*Thymus Serpyllum*), which grows in every lowland spot in France, mounts also to the tops of a great many of the Alpine heights. Even thyme (*Thymus vulgaris*), although belonging more exclusively to the more southern provinces, ascends the Pic d'Ereslids to above 2,000 yards.

Fox-glove (*Digitalis purpurea*), which is met with in all the lowlands in the west and midland part of France, grows on the Lozére, at 1,300 yards, and nearly at the same elevation on Mount Calm, along with *Rhododendron hederaceum*. In the same spot I have also noticed *Ranunculus hederaceus*, which grows in such abundance in Brittany, at the level of the sea.

Mat-grass (*Nardus stricta*) grows at the level of the sea, and it also forms the highest situated swards that are found in the Cevennes, the Alps, and the Pyrenees; it grows indifferently in marshy places and in those which are liable to dry up; so that it is found both on the tops of mountains where the snow disappears in the summer, and on the sides of those where this never disappears.

The spring-cinquefoil (*Potentilla verna*), which grows in low-lands, ascends the Pic de Bigorre as high as near 3,000 yards.

The snake's-head (*Fritillaria Meleagris*) is found in the west of France at the level of the sea, and on the Alps of Provence, at the elevation of nearly 2,000 yards.

Carex pauciflora grows in the plain of the Palatinate, at below 200 yards, at the borders of the lake on mount Cenis at 1,914 yards, and in the Alps of Dauphiny, at little below 2,500 yards.

The sweet vernal grass (*Anthoxanthum odoratum*) and the timothy-grass (*Phleum pratense*), which grow every where in France at the level of the sea, ascend to the elevation of 2,000 yards.

Several *Carices*, as *dioica, davalliana, ericetorum*, and *filiformis* have been observed at the level of the sea, and at 2,000 yards of elevation. The same has been noticed of *Scirpus Caricis, Sparganium natans, Juncus filiformis, Crocus nudiflorus, Orchis pallens, Thesium alpinum, Hippophae rhamnoides*, and of a crowd of other plants which I have enumerated in the fourth table.

I cannot pass over, while on this subject, the instance of the common juniper (*J. communis*) so abundant in every part of France at the level of the sea, and which presents itself again on the summits of the Alps and Pyrenees at 3,000 yards. The marsh lousewort (*Pedicularis palustris*) grows at Arles and at Ostend at the level of the sea, and on the Pyrenees at near 3,000 yards. The scorpion-grass (*Myosotis perennis*), which is common in all the flat country, grows, but reduced to miniature, in the Alps at 3,500 yards. Several of the gentians are instances of equally wide disproportions in their stations; thus *G. nivalis* grows at Fontainebleau, at about 50 yards, and at the pass of Venasque at about 2,400. *Gentiana campestris* is found in Normandy at near the level of the sea, and in the Alps at 3,000 yards. The mouse-ear hawkweed (*Hieracium Pilosella*) is met with as well on the sandy downs of Holland, as at 3,000 yards of elevation on the Alps.

The daisy (*Bellis perennis*), the ox-eye daisy (*Chrysanthemum

Leucanthemum), and the bladder campion (*Silene inflata)*, are all common in every quarter of France from 0 to 2,000 yards of elevation. The kidney-vetch (*Anthyllis Vulneraria)* is very general in all the lowlands, and grows likewise on Cambre d'ase and on Pic du midi at very near 3,000 yards.

I have taken all my instances from phænogamous plants, and from those about which there can scarcely arise a doubt on the score of identity. If I were to pursue the same course with the cryptogamous division of plants, I should meet numerous analogous instances, and such as would still more strongly confirm my opinion; thus most of the liverworts (*Lichenes*) collected by M. de Saussure, on the Col-du-Géant, and on mount Blanc, are likewise met with in the lowlands and lesser mountains; but I have purposely avoided all instances from cryptogamous plants, the identity of which is ever liable to doubts and objections.

3dly. When plants not suited by their nature to support an excess of either heat or cold, are found to grow in different latitudes, it is always at such heights as that the effect of elevation compensates that of the latitude.

Thus many of the plants of the Alps and the Pyrenees grow in the plains of the north of France, especially in the Ardennes and neighbouring provinces. Of these I have already cited some instances, and the fourth table is nearly made up of them.

Again, we know that many plants which belong to Lapland, or other countries of the north of Europe, when they are met with in France, grow there at considerable elevations. *Saxifraga groenlandica* grows in the Pyrenees very near to the summit of the Maladette, which is 3,278 yards high, and comes down to below 2,400 yards. *Linnæa borealis* is not found in the Alps below an elevation of 1,800, or 2,000 yards. *Cineraria sibirica* grows at about 1,600 yards on the mountains of Aubrac in Rovergue. *Menziesia Dabæcia*, which covers the lowlands in Ireland, is found in the western Pyrenees as high up as 1,000 yards. The chestnut grows in the lowlands of the north of France, upon the hills of the south of France, and at a great elevation on the Appennines, and at a still greater on

mount Ætna. But it is unnecessary to multiply instances now so generally known.

4thly. Plants which are the objects of husbandry are controlled by laws corresponding completely with the preceding. Such as grow in all latitudes, grow likewise at all elevations. Those that are only found in determinate latitudes, are found only in corresponding elevations. Thus we learn from M. de Humboldt, that the potatoe which succeeds so well in the north of our old continent, is cultivated in Chili as high up as 3,600 yards. We know that the cabbage thrives both down at the edge of the sea, as well as on the Alps at every elevation at which man can take up his abode.

Corn is also cultivated at very extraordinary elevations; I have seen rye in the departments of the Higher and the Lower Alps at 2,200 yards, particularly above Allos in Provence. Wheat does not grow so far to the north as rye, neither will it do so well as that at great elevations: yet I have seen it at near 1,800 yards. At such elevations sowing is generally done before harvest-time, that the plants may get strength before the snow falls; which has been known to have laid upon a crop of rye the year through: when this has happened the rye remained in *statu quo*, while the snow laid, and resumed its growth at the end of eighteen months, when that had melted away. It would be a curious experiment to try how many years rye could be kept alive under snow; we have here however an instance which goes to support what I have advanced in the Flora of France, on the inexactness of the division of plants into annual and perennial.

Cultivated plants which do not bear cold are under a like influence as to elevation. They can only be grown at such heights as correspond in temperature, with that of the distance from the equator to which they belong. In general, we reckon that a degree of latitude in these parts of the globe affects the mean temperature nearly in the proportion of 180 or 200 yards of elevation.

This rule, it is true, is liable to numberless modifications from local circumstances, yet I have had the curiosity to apply

it to the different plants of husbandry, and have obtained some results that may be worthy of recording. The most elevated point at which I found maize was grown as a crop, is in the department of the Lower Pyrenees, above the village of Lescans, at about the elevation of 1000 yards: now if we take our departure from that point, which is in the forty-third degree of latitude, and proceed five degrees upon the same meridian line,* we come to the neighbourhood of Mans, and to the south of the departments of Ille and Vilaine, which are precisely the northernmost points where maize is used for a crop.

The vines of Velai are those at the greatest elevation of any I have seen in France, at least in vineyards. The elevation of the town of Puy is computed at 632 yards, and the vineyards that belong to it go up to about 800. Now, if setting out from that point, which is a little beyond forty-five degrees of latitude, you take four degrees to the north upon the same meridian, you come to between Rheims and Epernai, that is to say, very close upon the northernmost limit at which the vine forms a branch of husbandry. With regard to the olive-tree, the local peculiarities of the countries where it grows are such as make investigations of this kind very intricate; it is generally cultivated in parts protected on the north by some vast range of mountains, where the mean temperature is consequently higher than it would otherwise be. When it is not sheltered by any range of mountains, the northernmost point in Europe at which we find the olive is Ancona, lying in 43° 37′ of latitude. In respect to the other point of view, I have measured its positions in several parts of Roussillon, Languedoc, Provence, and Italy, and these have been always nearly about 400 yards, which ought to indicate that the olive might grow two degrees more to the north than Ancona; now if we take two degrees towards the north from that point,

* I say upon a same meridian line, because it is well known that in the same latitudes there is a great difference between the east and west of France.

on a same meridian, we come to about lake de Harde, and the neighbourhood of Como, which are just the northernmost points at which the olive is cultivated. The fig-tree, which goes farther to the north than the olive, and not so far as the vine, preserves a corresponding gradation in regard to the elevations at which it will grow; but we can hardly determine any precise limit for a tree over which aspect has more power than the degree of positive heat. The same may be observed in regard to the walnut-tree, which reaches a little higher, both in latitude and elevation, than the vine.

These instances shew, that with us such wild and cultivated plants as receive their limits from mean temperature, receive them likewise from latitude and elevation, and that such as grow indifferently in almost any temperature, grow likewise in any latitude and at any elevation. A general law, which in itself tends to prove the effect of temperature to be more considerable than at first view it might have been deemed to be; but to come at a thorough knowledge of this subject, further details must be gone into.

We know that mean temperature can be but little relied on in estimating climates in regard to their vegetable produce. The distribution of heat in the different seasons of the year, has more power than any other cause whatever over the growth of vegetables, and of course over their geography.

Now it is found that elevation above the level of the sea produces an effect upon the distribution of heat, that corresponds perceptibly with distance from the equator; so that the nearer a place lies to either the equator or the level of the sea, the less difference there is between its winter and its summer; the farther it is either from the equator or the level of the sea, the greater is the disproportion between its winter and summer in point of temperature; and this is the reason why we perceive some analogy between the habits and appearances of the vegetation of mountainous countries and northern ones. In both the winter is long, cold, snowy, and pretty even in its temperature; while vegetation comes nearly to a stand, chiefly on account of the long continued lying of the snow; in both the summer is short and hot, and the

vegetation consequently rapid; in both unseasonable returns of cold in spring, and early and passing chills in autumn, are frequent occurrences.

In these facts, which, although generally known, I thought it right to recapitulate, we find a very simple reason for the correspondence which exists between the vegetation of the two kinds of climates. Consequently, for example, we find from the reports of travellers, that the tree which is the farthest in advance towards our pole, and shews itself far beyond the point at which pines and firs have ceased to grow, is the white birch; and it is that which is also found upon the Alps above the region of the firs. In general, evergreen-trees are not common in either northern or very elevated countries, where the snow, by gathering on their foliage, freezes their tender shoots by cold, or breaks down their branches by weight; none but those among the evergreens that have an acerose foliage, as firs and pines, can endure northern or elevated situations; and even these, as we have just stated, are left behind by the birch. In regard to wild plants, perennial ones are more numerous than annuals, in proportion to the increase of distance from either the equator or the level of the sea. The converse however of this proposition holds true as to several sorts of cultivated plants, and for a very simple reason. Those annual plants which are cultivated in a climate where the summer is short, have full time to complete their career of vegetation, and escape the perils of winter in the form of seeds or bulbs, secured from all accidents by human industry: but this is not the case with those whose protection is abandoned to nature. A single summer, which should be so far abridged by an early fall of snow, as to prevent the ripening of the seed of some particular species of annual, would be enough to expel the whole race from those parts; and this is no unfrequent occurrence in northern and very elevated countries. The scarcity of annual plants on mountains is a very obvious, but a very striking fact. Of about 1,500 plants which grow in France, at above the elevation of from 1,000 to 1,200 yards, I perceived only 15 that were annual or biennial, and even these were such

exceptions as confirmed the general rule. The annual plants that we find there, are of those kinds that abide by human dwellings, and the seed of which is continually restored by man to the places where frequent casualties obstruct the permanence of annual species; of these are the nettles, the shepherd's-purse, *Asparago procumbens*, &c. which always grow about the walls of hovels and farm-houses of high mountains. But excepting the sorts which man unconsciously carries about with him, no really indigenous annual plant is found at above 1,200 yards, at least the instances to the contrary are rare and doubtful.

§ II. *Of Elevation in regard to its Action upon Light.*

We know that light acts very powerfully upon vegetables. It stimulates absorption and secretion; it decides most of their apparent motions; it decomposes the acid carbonic gas, fixes the carbon in the vegetable fibre, and discharges the superabundant oxygen. When plants are deprived of this stimulus, they spindle, or in other words, become white, flaccid, and overgrow their strength. The more they are exposed to the action of light, the more they acquire of those qualities which are the opposite of spindling, that is to say, they form a greater quantity of carbon, deposite more woody matter, are of a deeper green, acquire a greater firmness, and are less drawn.

Nature increases the action of light in three ways: in the equatorial regions, by the illumination of a bright and powerful sun the year through; in the high northern regions, by a summer, that is to say, a season of vegetation, in which the days are long and the action of the sun unremitting; on high mountains, by rarefying and purifying the atmosphere, so as that the solar rays are enabled to act with far greater force than in the lowlands. This is the cause that the soft and delicate green of the plants of temperate lowlands is also met with in those of the tropics, and in those of polar regions or lofty mountains, except when the latter have been partly blanched by the long time they have laid under the snow.

The vegetables of the two last climates exhibit a very peculiar degree of correspondence.

The longer action of light in the north, and the brisker one upon mountains, are perpetually stimulating the plants, and accelerate their growth in a way that the round of vegetation is completed in the space of two or three months. By promoting the formation of carbon, it renders the organism of plants shorter and more robust: in drawn and spindling plants this is longer and feebler, and the bloom small and imperfectly developed; in northern and alpine plants, the flowers are generally larger and more perfect than usual. Drawn or spindling plants are very watery, and of course subject to be easily frozen; those of the north, or of lofty mountains, are well furnished with woody substance, and by that alone less liable to be affected by frost.

This effect of an increased intensity of light in particular regions, accounts for a multitude of facts which had been till now attributed to either the temperature or the rarefaction of the air, or of the stimulus of the oxygen with which it was imagined that snow water was largely impregnated, and is at the same time so manifest that it is wonderful that it should have been so long overlooked. It was M. de Humboldt who first drew the attention of naturalists towards this agency of light, and who has attributed to its peculiar influence the larger proportion of resinous and aromatic substances, which is found in the plants of the tropics and of lofty mountains, as compared with those of our climate. Is not the greater solidity of the wood (that is to say, the higher charge of carbon it contains) of several sorts of trees, such as pines and firs, which grow in the north, as compared with those of our milder climates, a consequence of the same cause? On the other hand, there are some trees, such as the oak, the wood of which is more solid and compact the nearer they grow to our southernmost regions. Again, is it not owing to this peculiar action of light, that the plants of lofty mountains are found to be so difficult to rear in lowlands, where their growth is enfeebled for want of a sufficient activity in this agent?

We find that they are in some degree drawn, and more subject to be destroyed by frost, than in their natural places. Is it not to this quality in light that belongs that air of correspondence which Reynier had already remarked between the plants of high mountains, and those of the sea side, of which the last of all that grow in lowlands, are the ones that receive the greatest share of light? Not to dwell longer upon these points of view, where theory and actual observation are so intimately blended, that one may suggest the other, I shall only add, that in general the greater portion of facts imputed by agriculturists to the action of air, are really to be referred to that of light. If it is thought that in this view I have given a greater degree of importance to the action of light, than the difference between its intensity on high mountains and that found in lowlands seems capable of bearing me out in, I answer, that I am not now giving opinions from theory, but from observations made upon the actual existence of the plants themselves. Every thing shews that these are affected by slight differences in light; we see this by their energy in directing themselves towards the spot where there is the most light, by the different hues they acquire on exposure to different degrees of light, as well as by many other signs. Alpine plants in particular, when cultivated in lowlands, shew all the marks of being deprived of a part of the light requisite to their well being.

§ III. *Of Height as affecting Moisture.*

In proportion as we ascend into the atmosphere, the hygrometer shews us, by its progressive fall, that the moisture of the air goes on constantly decreasing. This habitual dryness of the mountain air has the constant effect of increasing the insensible transpiration of plants; and as we know that their absorption by the root is perceptibly proportioned to their transpiration, it follows from this, that dryness of the air stimulates the functions of vegetable organs, and acting in concert with an intenser light, causes that rapidity of growth which is so justly the wonder of all travellers who witness it. Such acceleration of growth requires, during its period, the

soil to be well soaked with moisture, and this is really the case. The melting of the snow, more permanent as the mountain is loftier, moistens the alpine lands in all seasons; and we find a very considerable disproportion between the fertility of mountains where the snow lies the year through, affording a continued supply of moisture, and those where it melts in summer, and moisture is withheld just at the time it is most wanted. On the first, the plants thrive best in those spots which lie well to the sun. On the latter, they are of the longest endurance where they are shaded, or where they face the north; a difference which marks, at first sight, the vegetation of mountains of disproportionate elevations. Frequent showers and the contact of clouds, attracted by high points, are another source of natural irrigation for the plants that belong to mountains. Without this, the mountains where the elevation is below the limit of perpetual snow, would be much oftener bare of vegetation than they are actually found to be. The attraction of clouds helps also to counteract the effects of the habitual dryness of air on alpine vegetables. One circumstance which seems peculiar to the plants of mountains where the snow is permanent, is, that they are always moistened by very cold water; and notwithstanding we have not yet any theory that will enable us to estimate the influence the temperature of the water with which plants are supplied may have upon them, it will not admit of a doubt, but that it has its effect. Thus, gardeners are well aware that tropical plants must not be watered with very cold water, and are accustomed to take the chill off from that which they use for this purpose, by setting it for some time before hand in the hothouse. The reverse of this takes place in regard to mountain plants, and appears to have some sort of effect upon their geographical distribution. When a spring is met with on low mountains with water of a greater degree of coolness than the elevation of its scite prognosticates, we are sure to find also there the plants which belong to a greater elevation. *Rhododendron ferrugineum*, which, in general, is seldom found much below 1,500 yards, grows on mount Jura, in the bottom of the Croux du Van, at only 970 yards, but near a spot

where there is a spring, of which the water is only of two degrees of temperature, and probably proceeds from some subterraneous depository of ice. On the other hand, when we find warm springs at a considerable elevation, we often meet with, in the same place, vegetables which belong to lower and warmer situations; in this way, the *Adiantum Capillus Veneris,* or true maidenhair, which generally grows in our warmest provinces, and at the level of the sea, has been found by M. Ramond of Barège, at the side of water of the natural temperature of 32 degrees, and situated at an elevation of 1269 yards; and by myself near the warm springs at Vaudier, on the Piedmontese Alps, at the elevation of about 1500 yards. These are facts which may serve to confirm the important influence of temperature upon vegetables.

I have one more remark to make concerning irrigation, and which goes to prove its influence; it is, that in general, all plants in marshy, or watery places, appear to be more indifferent than any of the rest, to the effects of elevation, provided they have the irrigation they are accustomed to. Thus we see, that the turf-bogs of the Hautes Fagnes de l'Ardenne, which are scarcely above an elevation of 400 yards, present precisely the same vegetation as the turf-bogs at the summit of Mount Jura, which are at the elevation of 1600 yards. The Hautes Fagnes afford the *Ophrys paludosa,* and the quagmires of Jura the *Saxifraga Hirculus:* but, excepting those two species, all the others are common to both places. In the same way it will be seen, by running the eye over my tables, that most of the *Carices* and crow-foots which belong to marshes, and, indeed, bog-plants of all kinds, grow naturally, as well in the low-lands of the North of France, as upon the tops of our highest mountains, whenever they meet with marshy places.

§ IV. *On Elevation, in respect to its agency in the Rarefaction of Air.*

Let us now examine, whether the rarity of air, a direct and immediate consequence of elevation, has of itself an influence over vegetation? As it is admitted, that plants take up

a certain quantity of oxygen gas during the night time by their parts of a green colour, and both by night and day by the parts which are of another colour, it is clear that they can only exist in an atmosphere of sufficient density to furnish this; so that there can be no doubt of a certain height, at which the rarity of the air would put a stop to all vegetation; but this height appears to be beyond the limits at which the snow lies the year through; for all over the globe vegetation is found in every spot where the soil is not invested by eternal snow. Even below this point, there might, perhaps, be particular plants, that, being unable to dispense with a greater proportion of oxygen than is required by others, could not exist but at certain elevations: but here we must observe, 1st, that the whole quantity of oxygen taken up by plants is so small, that there is always more at hand than is absolutely necessary; 2dly, that they give out at least as much as they take up, and maintain a constant equilibrium on this score; 3dly, that plants which take up the least oxygen, are not among those, that grow the best on the tops of mountains; as a proof, M. Theodore de Saussure has found, that the succulent tribes of plants, are those which take up the least; now of about 50 species of this nature, which are indigenous in France, scarcely 20 grow in mountainous places, and of the numerous ones that belong to Africa and America, nearly all grow at the level of the sea; 4thly. that the plants which take up the most oxygen, such as the deciduous kinds, are among those, which, like the birch, ascend to the greatest elevations. There is nothing, then, which shews, that the quantity of oxygen inhaled by plants, has any relation with the elevation at which they can exist; or if it has an influence in the general effect of elevation, it is in a degree that is lost in the predominance of temperature, light, and moisture. M. Humboldt suggests, that the mere diminution of external pressure in the air, may likewise have some effect in encreasing evaporation: and this is really the only point of view in which we can admit of any direct agency of elevation; but the action must be infinitely small, and beyond the reach of computation, since we find very few plants that belong to

fixed and certain limits, in any situation but where the other causes have decided their stations.

In order to substantiate this conclusion by the general history of the plants of France, I have constantly noted down, with as much care as I could, those plants which I found at different elevations, and have constructed my tables from these notes. What strikes us on first casting our eye over the tables, is, that there are very few plants in which the difference between the highest and lowest elevations, at which they grow naturally, does not amount to 1000 yards; and in the cases of many, to more than 2000. Now, can we believe, that the degree of rarefaction of the air can have any very remarkable effect upon vegetation, when we find so many, and such important exceptions? I am well aware, that when we investigate the vegetation of a single mountain, or even of several that lie together, we then perceive a certain degree of regularity in the elevation to which certain plants go; but this regularity is always lost, when we come to compare distant places: now this is a general fact, that could not be accounted for, if the rarity of the air had any important influence, but which is, on the contrary, very naturally accounted for, if we admit that the influence of temperature predominates in the phenomenon.

I shall give in this place the general result produced by my tables. Of 5000 species of plants that belong to France, we are precluded from employing in our researches; 1st. 1500 of the cryptogamous class, upon which I have not ventured to rest any part of the support of my opinion, although the most of them made for the one, I hold; 2dly. 700 annual plants, which, for the reason I have mentioned above, cannot exist in places where the snow lays too long; 3dly. 300, that belong to the sea, which, as they require salt-water, can only be found at the side of the sea, or where there is salt; 4thly. 800 plants, which belong to the olive regions, and which, requiring a certain degree of warmth, can neither exist in our northern low-lands, nor in our mountains, and which probably on Mount Atlas, ascend higher than in Europe. Finally, 300 species, as yet too rare, or too little known, for me to hazard

any thing in regard to them. After all these exclusions, it will be seen that there remain about 1500 species from which we may be enabled to draw our general conclusions concerning the boundaries of plants in point of elevation. These 1500 species are classed by me in five tables.

In the first table I enumerate those which are scarcely ever met with at below 2000 yards, and of which some ascend to 3400; this contains 60 species, all perennial.

In the second, I have arranged those found at between 1000 and 2000 yards, and which keep pretty closely to this zone: here we have 206 species, all perennials.

In the third, will be found the species which are met with indifferently, at above one and two thousand yards, but which do not ever come down below 1000; this table, including 153 species, presents, even in that number, some instances of differences in elevation of from 1500 to 2000 yards, between the individuals of a same species.

The fourth, which is the most numerous, shews the species which are found indifferently, above or below 1000 yards, leaving out all those, the difference between whose *maximum* and *minimum* does not amount to 1000 yards. This table includes 517 species, among which we meet with frequent instances of differences in elevation of 2000 and 3000 yards.

The fifth table, was to have contained such as grow below 1000 yards, or thereabouts; but as it would necessarily consist of all those which are not in the other four, it has been omitted altogether.

On inspecting these tables, it will be seen that there is no such thing as generalising, in regard to the stations of genera and tribes: all that can be done on this head must apply only to each species separately.

§ V. *Conclusion.*

From the sum of the foregoing observations, along with those of my predecessors, I think that I am entitled to deduce the following propositions, as essential in botanical geography.

1st. That the rarity of the atmospheric air, taken indepen-

dently of every other circumstance, from between the level of the sea and the limit of perpetual snow, appears to have no very important direct influence over the stations of plants.

2dly. That the distribution of the plants of countries is principally regulated by the mean temperature and its annual vicissitudes.

3dly. That as the mean temperature of a given place is determined by its latitude, elevation above the level of the sea, and aspect, it follows, that the nearer we come to the equator, and from the greater consequent effect of latitude and aspect, the greater is the influence of elevation upon the stations of plants, while its influence diminishes as we come nearer to the poles.

4thly. That the annual changes of the temperature, as well as the degree of light and dryness, are the causes of the strong analogy there is between the vegetation of great elevations and that of northern regions.

5thly. That annual and biennial species of plants, or, more strictly, such as seed but once, become scarcer in proportion as we recede from the equator, or from the level of the sea. In our climates, there are very few that go higher up than 1200 yards.

6thly. That proceeding by the approximative computation, that in these climates, 180 or 200 yards of elevation act upon mean temperature nearly in the ratio of a degree in latitude, we come also at the means of determining the correspondence between the limits of vegetables, both in the scale of elevations and that of latitudes.

We omit the tables of the original, as too extensive for this work; and as less requisite from their results and general amounts having been fully stated in various parts of the treatise. These have been manifestly compiled at the expense of much labour, and are as reputable to the industry, as the preceding observations are to the sagacity of their celebrated author. Tr.

Nota. We have translated *metre* by *yard*, as the latter measure is more familiar to the English reader, and because, in fact, the difference between the two in the measurements here founded upon, is of scarcely any consequence. Tr.

ART. III. *Experiments on Stoving Cotton Goods with Sulphur, by Mr. and Mr.* S. HALL, *communicated with a Note by* MARSHALL HALL, *M. D.*

IN many manufactures of vegetable and animal substances into cloth, stockings, &c. it is found expedient to expose these articles to the fumes of burning sulphur, or of sulphurous acid gas. This is done to improve their whiteness; and to impart a soft, rich, and silky feel, which is deemed highly advantageous to the goods. But there is a disadvantage arising from this operation, which consists in the formation of a number of spots or specks, about $\frac{1}{8}$ and $\frac{1}{12}$ of an inch in diameter, resembling in all respects, and being in reality, small iron-moulds. Although the operation of stoving is employed in various manufactures, the ensuing observations must be considered as applying solely to the bleaching and preparation for sale, of cotton stockings, the writer's attention having been wholly confined to this part of the manufacture of Nottingham.

When the goods are stoved in a perfectly dry state the spots above-mentioned do not appear. But the advantage of the operation is then very trifling, and the goods are little improved in appearance and feel. To derive the full advantage in these respects, from the operation of stoving, the goods must be exposed to the vapour of burning sulphur in a moistened state. But they are then rendered less saleable by the appearance of the spots or iron-moulds.

The object of the experiments about to be detailed was at once to combine the good effects, with regard to the appearance and feel of the goods, resulting from stoving, and to obviate the appearance of the spots. These experiments have not proved successful. But it may not, on that account, be less useful to record them, for the information they convey may not only diminish the labour of any future experimentor, but may even suggest a new course of investigation; and it is, at least, an addition to the general stock of chemical facts. The probable conclusion from these experiments is, that small

portions of iron are derived from the sulphur, as held in solution in the sulphureous acid gas formed, and are at length deposited in distinct nuclei on the goods exposed to its action, so as to form the spots above-mentioned. With the view of preventing this formation of spots, the following experiments were made:

The clearest and purest sulphur of commerce, called virgin sulphur, &c. was first employed. The spots produced were less numerous than those occasioned by the common kinds of sulphur, but the benefit was partial and inconsiderable only.

Flowers of sulphur were then taken and sublimed to the third time; but still the experiment yielded no results of a decisive character.

Sulphur precipitated from the alkaline and earthy sulphurets by means of pure acids, still induced the same appearance of spots as before.

The same thing may be observed of sulphur purified by means of phosphorus: the phosphorus was first united under water with the sulphur, and then converted into phosphoric acid by continued boiling; much fe· uginous matter was separated, and this experiment seemed to promise success; but the result, although the most favourable of all, was far from being perfect.

Sulphurous acid gas, produced by the decomposition of sulphuric acid by means of charcoal and of mercury, still induced the spots, in the same manner as when it resulted from the combustion of sulphur.

Sulphurous acid gas expelled from the sulphates of the alkalis or earths, produced the same appearance of spots as before.

Sulphurous acid gas passed through acids, still retained the the same property of spotting.

The usual mode of stoving consists in burning sulphur in a close chamber, in which the goods to be stoved are hung. Besides this mode of experiment, many trials were made by exposing a little of the material of the goods to the action of the sulphurous acid, in a glass jar containing about six or eight pints of the gas. The cotton, in these experiments, was

moistened with a decoction of galls. Rather more than the requisite quantity of sulphur was placed on a bit of tile brought to a red heat, and placed within the jar. At first the sulphur burnt with its usual blue flame, but at length the flame became extinguished, and the sulphur was seen to sublime, the oxygen of the air being exhausted. After the cotton had remained about an hour exposed to the sulphurous acid gas, it was taken out free from spots; but the spots gradually began to make their appearance during an exposure to the air of about five or ten minutes.

In one experiment the sulphurous acid gas thus produced, was kept twenty hours before the cotton was exposed to it. The results were however the same as in the last experiment.

This paper is accompanied by specimens of cotton moistened with a decoction of galls, and, in the one case, spotted by the vapour of sulphurous acid in stoving, and in the other, by scattering over it a few small portions of iron. They will be observed to be perfectly similar.

Note by Marshall Hall, *M. D.*

Having ascertained by a course of experiments, which I am preparing to lay before the public, that, in the oxidation or rusting of iron by the agency of water, this fluid is not, as is generally supposed, decomposed; but that it acts as a medium only by which the oxygen of the circumambient air is conveyed to the metal, it has appeared to me that this view of the subject reflects some light on the formation of spots in stoving, and that it may probably suggest a mode by which the formation of these spots may be obviated.

1. The spots are not formed when the goods stoved are in a perfectly dry state.

2. The spots do not appear, even when the material is moistened, until it be allowed to come into contact with oxygen gas as contained in the atmospheric air.

3. These facts are equally observed, as I shall explain in the detail of experiments to which allusion has been made, in regard to the rusting or oxidation of iron moistened with

water; the water is not decomposed, but the oxygen of the surrounding atmosphere is conveyed to the metal through this fluid as a medium; and the oxidation ceases when the iron and air are perfectly deprived of moisture, or the air of oxygen.

4. The suggestion I would offer, therefore, respecting the operation of stoving is, 1. That the whole of the oxygen of the air be taken up, by continuing the exposure of the sulphur, heated to the requisite degree, in different parts of the close chamber; and, 2. That by continuing the same heat whilst the sides of the chamber are cooled by the external air, in order that they may condense the water thus evaporated, the goods be rendered perfectly dry before they are removed, and exposed to the atmospheric air. In this manner the improvement in feel and appearance would be obtained by stoving the goods in a moistened state; and the spotting would probably be obviated by first excluding oxygen, and then, by drying the goods before their exposure to the action of this gas.

Art. IV. *Of the three Species of the natural Order* Orchideæ, *represented in Plate* VI.

Mr. Francis Masson, the late intelligent and industrious collector of plants, while employed in 1775, at the Cape of Good Hope, in procuring supplies for the Kew Gardens, unexpectedly met with, among the Dutch soldiers who then guarded that colony, an artist of great skill as a designer of the objects of natural history. Availing himself of the circumstance, he formed a considerable portfolio of coloured drawings of the samples of the more curious objects of his pursuit; and especially of such as he deemed most refractory to exotic transplantation. They have been since added, by Sir Joseph Banks, to those treasures so long regarded throughout the world, to their possessor's and our country's honour, as the best funds of science.

Of these drawings it has been allowed us to make use of such as might suit this Journal, and we have selected for the present

Number, three rare and curious Orchideous vegetables, never represented from the living plant. Not long since the species of this order were looked upon as scarcely to be subdued to culture; but are now treated with as much facility as those of any other. No group in the vegetable creation is so conspicuous for the variety, as well as for the striking and extraordinary configuration of the blossom. Nor do we think that the beauty and singularity of the present specimens will be wholly useless in exciting to the pursuit of their acquisition, even those cultivators whose views do not extend beyond the gay and various appearance of their garden and conservatory.

Like the umbelliferous, papilionaceous, and syngenesious tribes, the *Orchideæ* compose a large naturally connected division, and are as easily recognizable by a pervading family likeness, as any of those groups. In the artificial system the species rank in the class *Gynandria*, (the column of fructification being viewed as the style, and bearer of the anthers) and in the orders *Monandria* and *Diandria* of the same. In the natural system, except the four primordial divisions derived from the absence of or the number of cotyledons present in the seed, no generally received and practically useful receptacles for orders, corresponding to the classes of Linnæus, have been devised. Insulated orders, on the other hand, teem from all quarters, to await the genius which is to combine the scattered groups to the use of science.

Previous to stating what we have collected of the particular histories of the species before us, we shall attempt an English version of the character of the order they belong to, from the Latin of Mr. Brown's Prodromus of the Flora of New Holland, in which the general features of this multiform and striking group are framed into one view, accompanied by remarks. Independent of their use as sub-strata for the construction of sectional and generic subdivisions, such schemes of the predominant features of extensive groups are the readiest introductions to an acquaintance with the species they comprise. They are in fact the guides through the maze of general likenesses and particular differences, combined in the groups of a system where those things are placed the nearest which differ the least.

Orchideæ.

Essential Ordinal Character. *Corolla* superior. *Organs of fructification* connate longitudinally, or only at the base. *Pollen* (in one or in two anthers) accumulated in masses of determinate forms. *Capsule* one-celled, with 3 many-seeded receptacles grown to the axes of the valves. *Seeds* minute, with an *albumen* but no *vitellus.*

Detailed Ordinal Character. *Corolla* superior, of six divisions, irregular, ringent, or spreading, rarely equal; fading away without falling off, (in vanilla connected by a joint with the germen, and deciduous) : *segments* in two ranks, separate or variously grown together : *external ones* 3, of which the *front,* or lowermost one (the back or uppermost one of other authors) generally becoming the rear or upper one by a twist of either the germen or the pedicle, is usually arched, but rarely spurred at the base : *the two hinder ones* (lateral or front ones according to other authors) of one size; most commonly differing in form from the front one; sometimes grown together below, and in some cases diminutive : *internal ones* 3, of these the *two side ones,* which often ascend along with the front one of the external rank, or converge towards it, or join with it at the base, are sometimes diminutive : *the third,* (the label) is opposite to the front one of the external rank, is in most species of a different form from the rest of the segments, and often grown to the base of the column of fructification, and is either entire or lobed, often one, seldom two-spurred at the base, sometimes with either a pouch or a spur at the top, on the inside sometimes either crested or bearded, now and then having an additional appendage, in some species it has an unguis, or narrow basement, the lamina or blade joining the unguis by an articulation, where the joint, in some few, is slightly irritable or responsive to excitement. *Stamens : filaments* 3, more or less connate or incorporated with each other, as well as with the style, situated within the front segment of the external rank, opposite to the label; *side ones,* in the vast majority of instances, sterile, and generally either much shortened or obsolete, now and then (as in *Cypripedium)* anther-bearing; *middle one* anther-bearing, seldom (and then the side ones each bear an anther) barren.

Anther two-celled, the cells either separate or grown to the sides of the column of fructification, which is often extended further on, or close together in one anther, which is sometimes parallel to an unadhering stigma, and fixed and permanent, at others crowning the column, and generally moveable, lid-shaped, and deciduous: in the great majority divided internally by a single longitudiral partition, rarely by three.

Pollen consisting of grains which are either simple, or often compounded of four spherules, collecting together at the time of fructification into masses of a determinate form, and corresponding in number to the cells, sometimes (where the anther is grown to the column, or more rarely when it is a terminal and moveable one) formed of numerous angular lobules held together by a gluey substance; sometimes (where the anther is parallel with the stigma, and more rarely when it is a terminal one) of a consistence approaching to powder, of a laminar form, with grains that are easily separated; and lastly, at other times, (when the anther is terminal and resembling a lid) of a waxen consistence, homogeneous, and smooth: after the cells have opened these become affixed to the stigma by one end which is generally tapered, either directly, or by the means of a filiform elastic process, which takes its rise sometimes in the pollen-mass itself, or is sometimes derived from the stigma.

Germen from nearly a round form to that of an elongated cylinder, ribbed, with three ribs more elevated than the others, and opposite to the exterior segments of the corolla, of one cell, with three parietal many-seeded receptacles opposite to the interior segments of the corolla.

Style grown together with the stamen either lengthways or only at the base, sometimes exceedingly short. *Stigma* slanting, generally facing the label, concave, secretory, now and then placed near the foot of the column, and somewhat horizontal; furnished at the top, or on the sides, with a single or a double uncovered gland to which the pollen is affixed, and which gland is either enclosed in its proper cell or case, or in the general one of the anther.

Capsule from ovate to cylindrical, three-valved, often broken into openings by the falling out of the pannels of the valves,

while a frame formed of the three prominent ribs remains standing and holding together at both ends.

Seeds very many, exceedingly small, generally furnished with an arillus or loose covering (perhaps more truly the integument or close covering ?) subulate at both ends, naked in *Vanilla.*

Albumen of the same shape as the seed, according to Gærtner.

Embryo minute, monocotyledonous, placed in the axis: *Radicle* in the umbilical region, and consequently centrifuge.

Whole order either herbaceous or suffrutescent. *Root* either tuberous or fibrous. *Stem* simple, rarely divided, leafy or else sheathed. *Leaves* simple, quite entire, sheathing at the base. *Flowers* arranged either in a spike, a raceme, or a corymb, or solitary, rarely in a panicle; one *bracte* to each flower. Pubescence, when present, simple, sharp-pointed, sometimes glandularly headed.

General remarks. 1. All other authors have called the flowers of the *Orchideæ* resupinate or reversed, when in reality they are upright. For the label before the flower opens is at the back of the flower, though afterwards, in many species, by a twist of the pedicle or base of the germen, it comes to be the front one.

2. The celebrated Dr. Swartz, who has distinguished himself so highly by his illustration of this order, has described the middle segment of the lower lip of Thunberg's genus *Satyrium* as the label, but is wrong in this regard, for the double spurred casque of this genus is the true label, or hinder segment of the inner rank, as its position in relation to the stamen and receptacle of the germen clearly proves.

3. As we find in *Cypripedium* that the side lobes of the column of fructification are anther-bearers, and the middle one barren, we may be allowed to consider the lateral lobes of the other genera, plainly to be seen in many, in some bearing anthers, though rarely, and in hardly any entirely wanting, as barren stamens. This view of the structure receives no inconsiderable confirmation from the analogy of *Phylidrum*, which although a genus very far removed from the *Orchideæ* as to many points, coincides with them very peculiarly both in the structure of the stamen and of the seeds.

4. The texture of the pollen-masses seems to be of great

value in a natural system. So that we have, from that circumstance, added a fifth section to the four established by Swartz, as yet a small one, to which, besides *Gastrodia*, the *Epigogium* of *Gmel.* wrongly associated with the *Limodorums*, belongs.

5. In many of the genera it remains yet to be decided whether the grains of their pollen are simple or compound. In those of our first section they are compound, exactly as in most of the *Apocyneæ* (considered as distinct from the *Asclepiadeæ*) with tufted seeds, in our second and third in all the species we have examined, we have observed them to be simple, even when inspected through a glass of high magnifying powers.

The genera of the order are divided into sections, to which a general character is prefixed. Our three species belong to two genera included in the first section; of which the following is the diagnosis.

SECTION I. Flowers with one anther, having separate cells that are grown to the column of fructification near the top. *Pollen-masses* of numerous lobules held together by an elastic substance, and with difficulty dissoluble into their component grains (themselves compound).

BARTHOLINA burmanniana. *Plate* VI. *fig* 2. Burman's Bartholina.

Generic character. Corolla ringent: inner petals grown together below with the label. *Label* spurred at the base underneath. *Pedicles of the pollen* elongated: cells grown to the column; the glands which bear the pollen-masses half covered by a small external lobe. *From the Latin of Mr. Brown.*

Bartholina burmanniana. *Brown in Hort. Kew. ed.* 2. 5. 194.

Orchis pectinata. *Thunb. prod.* 4. *Willd. sp. pl.* 4. 11.

Orchis burmanniana. *Lin. sp. pl. ed.* 2. 2. 1334. *Swartz in Weber und Mohr. archiv.* 1. 55 *tab.* 3; *(from a dried plant). Brown prod* 312; *in obs.*

Arethusa ciliaris. *Lin. fil. suppl.* 405.

Specific description. Tubers, twin, roundish, of the size of a large pea, covered with a fine white wooly nap. *Stem* about half a foot high, round, upright, villous, purple,

one-flowered. *Leaf* upon the stem near the root, only one, orbicular, stem-clasping, sheathing at the base, entire, spreading, slightly reflectent at the margin, fringed with hair, of a deep green above, paler underneath, veined, substantial and rather fleshy. *Root-sheath* at the base of the leaf above the root, equitant. *Flower*, terminal, having a convoluted sharp-pointed villous green *bracte* at the base of the germen, and shorter than that. *Corolla* of one piece, green: 3 *outer segments* forming the casque, united at their bases into a short gibbous tube, *blades or broad part of these* lanceolate, concave, blunt, smooth on the outside, villous within, marked with lines, side ones sometimes spreading and reflectent; *middle one* upright. *Two inner segments* lateral, lanceolate, upright, concave, making with the above a part of the casque, terminated by a filiformly lengthened apex, whitish, veined, with a blue longitudinal line. *Label* grown together with the base of the outer lateral segments, between concave and tubular, multipartite, every division (except the centre one which is linear and entire) subdivided to the depth of an inch into 3-4-6 linear spreading strips, white above, blue underneath. Throat of the tube marked with fine lines and dots of a bluish colour. *Spur* from under the base of the label, and grown together with its tube, blunt, slightly incurvent, much shorter than the germen, of a whitish green. *Germen* nearly cylindric, gibbous, tapered at the base, villous. *From the Latin of Swartz.* We have omitted the description of the organs of fructification, not to repeat what is found in the generic and ordinal characters.

DISA grandiflora. *Plate* VI. *fig.* 1. Large-flowered Disa.

Generic character. Corolla, ringent: casque with a single spur or a pouch at the base, inner petals grown to the column. *Label* spurless. *From the Latin of Mr. Brown.*

Disa *grandiflora*, casque sharp-pointed upright, spur conical pointing downwards, label linear blunt, stem generally two-flowered.

Disa grandiflora. *Lin. fil. suppl.* 406. *Swartz. act. holm.* 1800. 210.

D. uniflora. *Berg. cap.* 348. *t.* 4. *fig.* 7; (*from a dried plant*).

Satyrium grandiflorum. *Thunb. prod.* 4.

Orchis africana flore singulari herbaceo. *Raj. hist.* 3. 586.

Specific. desc. Stem a foot high or more, upright, undivided, smooth. *Leaves* shorter than the stem; root-ones lanceolately linear; stem-ones sheathing, with the blade shorter than the sheath, acuminate. *Flower* terminal, stalked, inclined, one or else two, and then the stalk of the last issues from the spathe of the first on a longer stalk. Native of the Cape of Good Hope.

Disa spathulata. *Plate* VI.* *fig.* 3. Spoon-lipped Disa.

Disa *spathulata*, casque upright sharp-pointed, label stalked with a dilated trifid top, stem few-flowered, leaves linear.

Disa spathulata. *Swartz in act. holm.* 1800. 213. *Willd. sp. pl.* 4, 52. *Hort. Kew. ed.* 2. 5. 197.

Orchis spathulata. *Lin. fil. suppl.* 398.

Satyrium spathulatum. *Thunb. prod.* 5.

Specif. descr. Root-leaves, many, linear; as short again as the stem. *Stem* about half a foot high, sheathed, with sharp-pointed scarriose broader leaves. *Flowers* generally two; alternate. Casque of the *corolla* stalked very shortly spurred, heart-shaped. Two *side-petals* ovate, acuminate or long pointed. *Label* heart-shaped, with a filiform stalk twice the length of the other parts of the flower. Native of the Cape of Good Hope.

* This plate, and plates VII. and VIII. were printed at the *Lithographic Press* of *Messrs. Moser and Harris*, 71, *Cromer-street, Brunswick-square.* When it is considered that by this art, drawings are multiplied to any extent, without either the expense or the labour of engraving, there can be little doubt but that it will in a short time be much more generally adopted in this country. Although the process is simple, yet much care and delicacy are requisite, in order to procure perfect and distinct impressions. Mr. Moser, who has just set up two presses in this country, was for some time employed at several of the most considerable lithographic establishments on the Continent. The drawing of plate VIII. having been imperfectly made on the stone, is the cause of the appearance of the plate.

Art. V. *On the Influence of Mental Impressions in producing Change of Function in the Living Body.* By J. R. Park, *M. B. F. L. S. & M. R. I.*

The phenomena produced by mental impressions, or the influence of the passions on the bodily frame, are almost universally classed among those arcana of nature which science has hitherto been unable to explore.

The substitution of a few technical phrases, which here, as elsewhere, has supplied the place of explanation, is now generally admitted to serve only as a subterfuge for ignorance.

It is usual to divide the passions into exhilarating and depressing; and it is assumed, that their influence is primarily exerted upon the action of the heart, one class operating as a stimulus, and increasing its activity, while the other diminish it by acting as a sedative.

To say nothing of a number of facts which are wholly incompatible with this view, it may be easily shewn, that it does not explain those very phenomena for which it was expressly designed.

The paleness and tremors that accompany excessive fear, for instance, cannot be accounted for in this way; for impaired circulation, though it may occasion paleness, and even fainting, if the cause be sufficient, as loss of blood, yet was never known to produce those violent tremblings which, in extreme fear, cause the teeth to chatter, as it is termed, and agitate the frame like the cold fit of an ague.

But, further, there are many effects arising from mental emotions which are merely local, and therefore not explicable by a cause that is general, and must operate alike on all parts, as altered action of the heart. We cannot refer to this organ, for example, the suffusion of the face from shame, nor the flow of tears from grief.

Should the solution of these phenomena which follows, be thought more satisfactory, or the principles on which it rests, appear new, it is but just to acknowledge, that they in part

derive their origin from hints that may be found in the writings of preceding authors, especially Whytt, Bichât, Darwin, and Hartley.

According to Whytt, the human frame considered as a sentient being, owes the exertion of its automatic movements to the influence of impressions inconsciously made upon its internal organs, constantly and uniformly prompting them to action.

Now the regularity of their action is liable to be disturbed by more powerful impressions from without, change of feeling causing change of action. And such changes may be effected either by causes acting corporeally, as already shewn, or they may proceed from those which act mentally, as remains to be explained; the sentient faculty being alike susceptible to the influence of both.

Such is the general principle upon which the operation of the passions appears to depend; while the different effects produced by distinct emotions, will be found to result from the peculiar nature of each.

As the object, however, at present in view is, to investigate their physiological effects, rather than their metaphysical nature and origin, the latter will be considered no farther than is indispensable for accurately defining the terms employed.

It will not be necessary to inquire, whether each be the result of a separate propensity, or spring from the combined influence of several: nor will there be occasion to enumerate all the forms and varieties they assume, as their general mode of action may be sufficiently illustrated by selecting the most important, the others being either modifications of these, or analogous in their operation and effects.

The most essential in a physiological point of view are, grief, joy, fear, hope, anger, and love; their influence is most clearly evinced, and their excess productive of the most serious consequences.

Others of minor importance are, anxiety, which is merely an alternation of fear and hope; pity, which is sympathetic grief, or participation in the sufferings of another; hatred, which is a less active, but more permanent form of anger;

jealousy, which is compounded of love and anger; and envy, which is a compound of anger and ambition.

Besides these, there are some others, such as pride and shame, which may be distinct emotions, but are either too limited in their influence, or too transient in their effects to merit separate examination. The first six appear to be more particularly deserving of attention.

From observing the phenomena of the passions, the general conclusions to be drawn are as follow.

First. That mental impressions act primarily, not upon the heart, but on the brain or organ of mind; this being the only part endowed with reflex consciousness, and capable of moral feelings. The participation of other parts is secondary, and results from their connection with the sensorium.

Secondly. It appears, that moral feelings act upon the brain, or organ of mind, just as physical impressions do upon the organs of sense. Corporeal impressions alter the circulation of the sentient organs, so mental feelings affect the circulation of the mental organ.

Thirdly. It will be found, that the changes first produced in the brain, and thence communicated to other parts owing to nervous influence and connection, have also their immediate seat in the vascular system, and are propagated just as the influence of corporeal impressions is extended to distant parts, through vascular sympathy.

The accuracy of these conclusions will be shewn in the separate examination of each passion, and the careful analysis of the phenomena it presents.

GRIEF.

Grief certainly cannot be considered as a pleasing emotion, yet there is one circumstance remarkable in its moral tendency, which is, the willing abandonment it occasions, disposing the sufferer to indulge in sorrow, with an apathy or indifference for every thing unconnected with its object. The very calls of nature, hunger, and thirst, and even bodily pain, are disregarded in the state of torpor and abstraction it occasions.

Now this peculiarity in its moral nature, appears to modify

the influence of grief on the bodily frame, which causes every function to languish, as the symptoms declare.

The marks of bodily participation in the effects of grief, are evinced by a sense of weight and fulness in the head, with flushing of the face and redness of the eyes. These are accompanied by deep sighs, and interrupted respiration. In early life, and moderate grief, a copious flow of tears usually attends, and affords manifest relief: but in more advanced age, and in excessive grief, this relief often fails, and worse consequences are apt to ensue, such as acute pain in the head, actual inflammation, an attack of mania, or convulsive affecfections, epilepsy, apoplexy, or sudden death.

That the brain is the primary seat of the changes produced, appears from their visibly occurring first in parts contiguous to this organ; while the nature of the symptoms, namely, redness of the face and eyes, with sense of fulness in the head, declares them to reside in the vascular system, and to consist in determination of blood to these parts.

To account for their production, one of two causes must, in strict reasoning, be assigned:—either the blood is sent more forcibly than usual to these parts, or it meets less resistance than usual when it arrives in them; its quantity would not otherwise increase there.

Now grief surely does not belong to the class of exhilarating passions, which are caclulated to operate as a stimulus, and accelerate the action of the heart; on the contrary, circulation is, in fact, found to languish, like every other function, and the pulse becomes slow and irregular.

Still, however, the blood accumulates in the vessels of the brain and parts contiguous to it; and since there is no increase in the impulse with which it is sent to them, there must be a diminution in the resistance which these vessels oppose to the force of the fluids distending them; for this is the only remaining cause that can be alleged to account for the unusual congestion they undergo. The point then to be ascertained is, why they oppose less resistance now than usual.

Here the same reasoning which explains the determination of blood occasioned by local irritation, or the redness produced

on the surface by sensible impressions, offers also a satisfactory solution of the congestion produced in the brain by mental emotions.

The vessels, in common with other involuntary organs, owe the exertion of their moving power to the susceptibility of internal irritation. The distending force of the blood within is the cause which habitually prompts them to exertion; and the equable resistance they oppose, causes them to maintain at other times a nearly uniform degree of contraction. But when a more powerful impression from without, obscures or effaces the force of the impression within, their resistance is for a time suspended or diminished; they yield to the distending fluid, and thus determination of blood to the part ensues.

In the passions, the brain is the primary seat of this change, because mental impressions are adapted to act upon the organ of mind; but other parts indirectly participate, especially those contiguous to, and dependant upon the sensorium, conformably with the laws of vascular sympathy.

The vessels, like other parts which are susceptible of irritation, owe their sentient faculty to the nerves that enter into their texture, and derive these nerves from different sources, some from the cerebral and some from the gangliac system.

There is no sufficient reason to doubt, that the capillaries receive their nerves from the same source as the organ of which they form a part. It is therefore to be expected, that these vessels should partake of the nature, and participate in the affections of the parts to which they belong.

Now the external surface and voluntary organs being chiefly supplied with cerebral or spinal nerves, while those of the internal surface and viscera derive theirs principally from the gangliac sytem, it is easily conceived why the vessels of the surface participate more in mental emotions than those of the centre; and why those of the face, which are contiguous to the brain, are more subject to mental influence, and shew more sympathy in sensorial impressions than the rest of the surface; while those of the brain itself, the organ and imme-

diate seat of moral feelings, are, of all others, soonest and most affected by impressions on the mind.

The flow of tears is referable to the same general cause; the contiguity of the lachrymal glands occasioning them to participate in the effects of this local determination, augments their secretion. Nor is the change confined to them, but extends also to the conjunctiva of the eye and to the mucous membrane of the nose.

That determination of blood to these parts is calculated to produce increased secretion, appears from similar effects attending other affections, which are alike productive of determination, such as catarrh, meazles, influenza. And that grief, by operating upon this general principle, occasions a flow of tears, and not from any peculiarity in its moral nature, exclusively belonging to itself, is seen from the same effect attending other mental emotions totally different in their moral nature, and some diametrically opposite to grief, such as joy and laughter.

During childhood, the flow of tears is more readily called forth, owing to the more active circulation attending the growth and evolution of each organ, as explained by Cullen, and consequently the greater mobility of these parts, that prevails in early life.

Why tears, that flow in moderate grief are often suppressed in that which is excessive, is explained by the principle formerly stated, relative to the alternate action of vessels and their mouths. The mouths, like sphincters, contract when the vessels or ducts leading to them relax, so as to become over-distended. Hence, relaxation of secreting vessels within certain limits only, augments secretion; when excessive, it excites contraction of the excretory mouth, and suppresses secretion again. Accordingly, tears are the effect of moderate grief, while that which is excessive produces often worse consequences, as convulsions, mania, or inflammation of the brain.

The cause of sighing was long ago suggested by Dr. Whytt, who thus pointed out the true principles on which the explanation of the other symptoms was to be sought for.

Respiration is one of those functions which immediately depends upon the sensorium, and proceeds from cerebral or spinal nerves; its ready participation in mental impressions is therefore to be expected. In ordinary respiration, the effort of expanding the chest is unconsciously excited by the uneasy sensation attending accumulation of blood in the lungs; but under the abstractive influence of grief, the sentient faculty, either impaired or diverted from internal impressions, suffers the accumulation to proceed to an unusual degree, and then a greater effort of inspiration is called for to obtain relief, which, followed by a fuller expiration, constitutes a sigh.

The irregularity of the pulse naturally follows interrupted respiration. The blood detained in the lungs now returns more slowly to the heart and retards the pulse; the next moment, hurried on by a deeper expiration, it presses forward to the heart and quickens the pulse.

Thus the ordinary and familiar effects of grief are all applicable upon the principle by which Dr. Whytt happily explained the cause of sighing; the organs of circulation and those of respiration being alike subject to the influence of mental impressions.

As for the extraordinary or anomalous symptoms that occasionally present themselves in certain individuals, these may be readily accounted for upon the principles formerly established in tracing out the laws of organic sympathy.

If any organ be more sensitive than the rest of the system, this will be most easily affected by a general cause. If the tone of its vessels be impaired by previous disease, or constitutionally weaker than that of others, the sympathetic change will be greater here than elsewhere; the tendency to sympathise increasing along with the irritability. Thus persons subject to liver disease often experience a relapse upon any distressing occurrence; and those of weak digestion are liable to a return of their stomach complaints, from any thing that occasions mental uneasiness.

In chronic diseases, the baneful effects of sorrow preying upon the mind, are well known to every medical man, who

must often witness the inefficacy of the most skilful treatment, until some happy change of circumstances revives the spirits of his patient, and restores the functions to their natural activity. Such is the salutary effect which attends the operation of the reverse of this passion, or,

JOY.

The moral tendency of joy is diametrically opposite to that of grief; while the latter creates an aversion to motion, and begets a state of listlessness or torpor, impairing the susceptibility of impression and impeding every function; the former, on the contrary, disposes to action, renders the body alive to every impression, and diffuses a general alacrity throughout the system.

Its physical influence cannot therefore be otherwise than salutary, at least when the emotion is moderate in degree. The circulation through the capillary vessels is facilitated by it, the blood is determined towards the brain and surface, a pleasing glow is excited over the skin, and every function which languished under the depressing influence of grief, becomes active again under the enlivening impression of joy.

These effects are not to be ascribed, any more than those of grief, merely to a change in the action of the heart. This organ, like every other, may participate in the general increase of activity; but such a change, if it occur, is only a secondary effect, and wholly inadequate to produce the other phenomena attending this emotion.

Joy, like every other mental feeling, first exerts its influence on the brain; where it operates as sensible impressions do on the organs of sense. These act upon the circulation of the sentient organ, and when of a pleasing nature, cause relaxation of vessels and determination to the part. Joy, which is analogous to pleasure, affects in the same way the circulation of the brain, and causes determination to the sensorium.

This determination, in conformity with the laws of vascular sympathy, extends also to other parts, and if the cause be sufficiently powerful, the whole system may feel its effects. These, when moderate in degree, are widely different from

those of grief, the relaxation of vessels being unattended with any torpor and inactivity, but every way analogous to the effects produced on the surface by warmth and friction, or in the stomach by cordials, occasioning a more free and active circulation.

The pulse is alike accelerated by grateful impressions, whether they be corporeal or mental, from their influence on the heart; and the additional impulse thus given to the blood will tend to modify the general effect, and increase determination to the surface and brain.

The participation of the heart, however, appears to be only secondary, in joy as well as in grief. The returning blood is retarded in the one instance, and accelerated in the other, and the action of this organ varies accordingly. It is possible indeed that the mobility of the heart, varying with every change in the state of its coronary vessels, may experience a more direct participation. The coronary vessels being subject to the general laws of vascular sympathy, and this organ being furnished in part with cerebral nerves, its vessels may, like others, participate in sensorial impressions, thereby acquire a more free circulation, and alter its mobility. But the isolated position of the heart, in conformity with the general phenomena of vascular sympathy, renders it likely to be exempt from such direct participation; while the effects of the passions present no changes in its action but what are fully explicable by the augmented or diminished impulse of the returning blood.

That the capillaries are subject to nervous influence is manifest from the visible changes they perpetually undergo, both from corporeal and mental impressions; and the nature of these changes indicates the manner in which they are produced. Determination to the brain and surface is obviously the immediate effect resulting from joy as well as from grief; but the opposite nature of these emotions requires that they must act upon some intermediate principle common to both. Relaxing the capillary vessels appears to be the point wherein they coincide in their mode of operation, and the contrast between the emotions sufficiently accounts for the diversity of

their effects, when moderate in degree; grief producing relaxation of vessels, through the torpor and abstraction it occasions; joy effecting the same change through its affinity to pleasure, which disposes the organs to yield to grateful impressions, but without impairing their mobility.

When the emotions are experienced in an extreme degree, a striking coincidence, as before noticed, is observable in their effects,—both producing extraordinary congestion; and on the principle just stated it would appear, that the excess of joy is at least as dangerous, if not more so, than that of grief. In grief the vascular relaxation being accompanied by a general torpor, and no increase occurring in the force of circulation, the congestion in the sensorium is merely passive, and less liable to be excessive; whereas in joy the action of the heart being rather augmented than impaired, the yielding of the cerebral vesels will be simultaneous with increased circulation, and thereby threaten greater determination to the brain.

It does not appear foreign to the subject to notice here, that the subjection of the capillary vessels to nervous influence has of late received confirmation from the evidence of experiment. Mr. Brodie shewed some time ago, that secretion may be suspended by the division of nerves. M. Le Gallois has lately shewn that congestion in the minute vessels of the lungs results from the abstraction of nervous influence. And more recently still Dr. Philip has proved, by a series of experiments equally ingenious and important, that all involuntary organs are subject to the influence of nerves.

It is true, Dr. Philip explains, in a different manner, the way in which he conceives nerves to act in producing secretion and vascular action; but his arguments on this point are not equally conclusive.

Because secretion is suspended by division of nerves, although the secreting organ continues to receive a supply of blood, Dr. Philip concludes that the failure of secretion does not proceed from the loss of vascular action, but from the want of nervous influence to effect the changes in the blood; which he conceives it to accomplish as a chemical agent.

Now supposing Dr. Philip's idea of secretion to be just,

still the want of nervous influence to act as a chemical agent should only change the quality of the secreted fluid, and not totally suppress the quantity poured out on the secreting surface. This surely implies some change of action in the secreting vessels.

Whenever secreting vessels, from loss of power, become relaxed and over distended, their excretory mouths, in all cases, as formerly shewn, become constricted, and secretion suppressed; hence the most abundant supply of blood is unattended with secretion in fever and inflammation; and similar is the effect that results from division of nerves.

However plausible are Dr. Philip's speculations on the nature of nervous influence, and whatever benefit may accrue to science from searching after the cause of secretion and vascular action; still it must be admitted that their laws can only be deduced from observance of their phenomena; just as the laws of gravitation have been inferred from its phenomena, and not ascertained by attempts to discover its cause.

FEAR.

Grief and joy are easily defined, but there is an ambiguity in the effects of fear, partly arising out of the indiscriminate use of the word, and partly out of the fluctuating nature of the emotion.

The term fear, is in fact applied to a variety of feelings; thus we are said to fear pain, to fear disaster, or to fear disgrace; each of which implies a distinct emotion: and the effects of fear, when the word is thus indiscriminately used, appear devoid of uniformity.

Its effects can only be uniform when the emotion which causes them is so; and it is therefore necessary to restrict its meaning at present to one distinct sense.

The least equivocal instance of fear is perhaps that which arises from the apprehension of personal danger. Similar also in its effects is that superstitious dread which the vulgar feel at the sight of what is supposed to be a supernatural appearance; and its influence is probably owing to the same cause, or a sense of personal danger, hence it is much increased by conscious guilt.

In this sense the effects of fear on the bodily frame are sufficiently definite and uniform; but still they are liable to be mistaken from the fluctuating nature of this emotion.

The mind, under the influence of fear, is seldom wholly divested of hope, and their effects may be easily confounded; thus fear, which takes away the strength, is sometimes erroneously supposed to increase the muscular energy; an effect which, if well considered, will be found to arise from the sudden renewal of hope.

In this restricted sense, the genuine effects of fear are first visible in the countenance; the blood flies from the face, the surface becomes pale, or bedewed with a cold sweat, the strength fails, and the limbs are affected with violent tremblings, which agitate the whole frame; the eyes become fixed, the breathing interrupted, and along with these an oppression is felt at the chest, and often violent pulsation at the heart.

The subsidence of these symptoms is followed by the occurrence of others of an opposite nature; which may either be regarded as the secondary effects of fear, or the immediate effects of hope, for cessation of the one is almost synonymous with renewal of the other. At all events, the symptoms in question invariably follow, and appear to be a necessary consequence of those which precede, and must therefore be taken in conjunction.

If the cause of fear be transient, at the moment of its removal, the blood rushes back to the face and surface; heat and redness arise with throbbing in the arteries, and increased action of the heart, and perhaps severe head-ache, with thirst and fever come on. Where organic weakness prevails, local disease may ensue, causing in one person a fit of gout, in another an attack of asthma, or other effects according to the constitution of different individuals.

Both these and the former symptoms evidently proceed from altered circulation; the paleness and shrinking in the first stage denoting want of blood in the capillary vessels; whereas the heat and redness indicate excessive determination to them in the second. The cause of this change is the point to be ascertained.

Reasoning as formerly, one of two causes must be assigned to account for want of blood in the capillaries of the brain and surface: either it is not sent to these parts as usual, or the vessels do not admit it as usual.

To say nothing of the inadequacy, before noticed, of diminished action in the heart to produce those violent tremblings which agitate the frame in fear, a strong sense of throbbing or beating at the chest is one of the first effects of this emotion; which shews that there is no diminution, but rather an augmentation of effort in the heart, and therefore the cause of emptiness must be sought for in the vessels themselves.

The natural effect of painful impressions, as formerly shewn, is to excite contraction. There is indeed an apparent exception to this law, and that is, when the irritating cause is externally applied, relaxation being then the result. This, however, was shewn to be really no exception, but a corollary necessarily arising out of the law. In this instance, the irritating cause is applied to a part not capable of contracting, and only causes relaxation, or suspends contraction in a part contiguous to it, which is so, by effacing or obscuring the impressions actually made on that part.

Thus it appears that the direct effect of pain is uniformly the same, or contraction; and analogous to the operation of pain is that of fear, or the apprehension of pain. As actual pain constricts the vessels in the sentient organ; so apprehended pain excites undue contraction in the capillaries of the brain, or mental organ.

The paleness and constriction thus appear to arise from an unusual effort of contraction expelling a portion of the blood previously contained in these vessels, and impeding the afflux of that coming to them; but without any diminution of action in the heart, and even while the heart is struggling to relieve itself from the additional load of blood now thrown upon it. For this change originating in the vessels of the brain, soon extends to other parts by vascular consent, especially to those immediately subject to sensorial influence, as the face, the surface, and organs of locomotion; and, in this way, violent

throbbing at the chest arises from the superfluous blood now thrown upon the heart.

The secondary symptoms are easily accounted for on principles previously ascertained. Inordinate contraction is ever followed by proportionate relaxation; and the cause of fear subsiding, the constriction of vessels ceases, and the blood is sent back with additional force to the capillary system; for the relaxation succeeding is for a time accompanied with increased action of the heart; and hence the liability to convulsions, or inflammation of the brain in the second stage of this emotion, when excessive.

The operation of fear is thus explicable upon similar principles to the production of a febrile paroxysm, to which it bears, in many respects, a near affinity. This explanation of fever, however, it is to be observed, is materially different from that proposed by Hoffman and Cullen, the particular consideration of which would be foreign to our present subject.

ANGER.

This passion owes its influence on the bodily frame to the same general principle as other mental emotions, namely, change of feeling causing change of action in the cerebral vessels; but is sufficiently distinct from every other in its mode of operation.

Its effects accord, in many points, with those of grief, each causing increased determination of blood to the sensorium, but in both accompanied with certain peculiarities arising out of the different nature of these feelings.

Anger does not, like grief, produce a general torpor and insensibility, but awakens all the energies of the mind, and stimulates to exertion. When a sense of wrong fires with indignation, or the feeling of insult inflames with resentment, every muscle is instantly in readiness for action; and the fresh impulse thus given to the blood modifies the general effect, and augments determination to the brain and surface.

Consequently, flushing of the face, redness of the eyes, throbbing of the arteries, quick and strong pulse, with deep and laborious respiration, are the usual symptoms of anger.

When the emotion is extreme in degree, the coincidence of its effects with those of grief and joy, bespeaks the community of the principle on which they act; thus anger, like these, produces inflammation of the brain, mania, apoplexy, or sudden death. Or if organic weakness prevail in other parts, rupture of vessels, effusion, congestion, or local inflammation may ensue, as explicable on the principles already pointed out.

A case related by Dr. Gregory of Edinburgh, in his Lectures, illustrates the distinct effects of the extremes of anger and grief in a manner so forcible and impressive as entitles it to insertion.

A woman, whose husband had been long absent at sea, and was supposed to be dead, had married a second; but the first husband returned and claimed his wife. She went back to him, and after they had lived some time happily together, she had a child by him. When her child was not many weeks old, and the mother's strength imperfectly restored after her confinement, she happened to quarrel with a female neighbour, and a scolding match ensued; when her antagonist insinuated that she had married her second husband, knowing the first to be alive. The indignation excited by this unjust charge brought on an attack of mania, and some time elapsed before she was restored to her mind. In the mean while her child, given in charge to another, was shamefully neglected; and when it was brought back to the mother, the shock occasioned by the change gave rise to an immediate attack of catalepsy. She now became perfectly inconscious of all around her, with her eyes fixed, her body motionless, her pulse and breathing scarcely perceptible. In this state, if a limb were raised or extended, the muscles becoming rigid, for a short time retained it so, until they relaxed again, and it gradually fell into its former position. The various means that were now employed to restore her, all proved fruitless, till it was at length deemed expedient to try what the sight of her child might do. It was brought to her, but she remained wholly regardless of it; until after repeated attempts it was placed directly before her face, when she appeared to become sensible of it, and shortly

after followed it with her eyes, and smiled, and at last stretched out her arms to receive it. When given to her, however, she pressed it to her bosom with a convulsive force, so as to endanger its life, and its removal became necessary. Mania now instantly returned, and on subsiding was again succeeded by catalepsy, which alternated with each other for the space of three days, until she expired.

LOVE,

The last of the passions that requires to be considered, presents, in its analysis, an epitome of all the rest; for so various are the feelings which it calls forth, and so intimate its union with the emotions it awakens, that they appear essential to its existence, and this combination forms one of its most striking peculiarities.

Taken in the more refined sense, love may be defined as—that attachment between the sexes which springs from a mutual sympathy, or congeniality of mind.

In another, and less exalted acceptation, this passion becomes degraded into a mere appetite; and its phenomena, in this light, are reducible to the laws of physical impressions. As far as the mind indeed is concerned, it affords a more remarkable illustration, than any other emotion, of the coincidence of effects between corporeal and mental impressions in altering the state of circulation; pleasurable feelings operating in the same way on the capillary system, whether they act through the medium of the mind, or by their immediate impression on the sentient organ.

In the more refined sense of the word, love is calculated to awaken all the inherent sensibilities of our nature, and on this account diversity of effect is its most prominent feature; the actual symptoms it presents being explicable only by reference to the concomitant emotion. Thus joy, grief, fear or hope, anger or jealousy, may be called by turns into action, and one or other of these is always blended with love.

If sense of cold, constriction of vessels on the surface, with slight tremors and palpitation attend, these must be referred to a degree of anxiety or apprehension, such being the operation of fear.

If frequent sighing, and a sense of sinking or oppression at the chest arise, these must result from a disposition to despondency prevailing at the moment, these effects being referable to the operation of grief.

If sudden flushings of the face, hurried respiration, and irregular pulse occur, jealousy is probably called into action, such being the effects of anger.

If a pleasing glow over the surface, with slight acceleration of pulse, and a general increase of health and alacrity attend, these, as Darwin observes, denote the happy lover, being the effects of joy, or of hope, the anticipation of pleasure.

And thus the apparently contradictory effects may be explained, that result from this emotion, which presents, in fact, a compendium of all the passions.

In short, the various operation of mental impressions ultimately resolves itself into one general principle, or change of feeling, causing change of action in the cerebral vessels; while this change through vascular sympathy, extends to the whole system.

The reason why this general principle is so variously modified in particular cases, can derive no illustration from the vague and indefinite meaning of the technical terms stimulant and sedative, but is to be found, as already shewn, in the peculiar nature of each separate emotion.

There yet remains to be considered a number of phenomena, which evidently belong to the class of mental impressions, and deriving their influence from the same source as the passions, are calculated to throw light reciprocally upon each other.

They are, for the most part, ascribed to sympathy, although there are many to which this term is wholly inapplicable.

MENTAL SYMPATHY.

Organic sympathy, which was formerly considered, causes one organ to participate in the impressions made upon another; the influence of mental sympathy, as it is called, is more extensive, and causes one person to participate in the feelings and emotions of another. Thus seeing another yawn,

or hearing another cough, excites often a propensity to yawn or cough in the observer.

Although these effects may, in compliance with custom, be termed sympathetic, yet the word conveys no explanation of the manner in which they are produced; and there are, besides, many cases of similar effects, to which the term sympathy is inapplicable, as they are occasioned by inanimate objects. Thus the sight of blood causes some to faint; the sight of food causes the saliva to flow from the mouth of a dog.

Now these effects, and many others which are differently explained, are perfectly analogous to those called sympathetic, and without multiplying principles and inventing new causes, as the sympathetic tendency, the imitative principle, the power of imagination, and others, may all be shewn to proceed from the same source.

The common principle to which they all apparently owe their origin is, the influence of attention inconsciously directed to particular parts, varying the degree of mental energy exerted upon, or the nervous influence sent to them, thereby altering their action, and producing a transient change of function.

How attention acts in directing the energy of the mind more strongly to particular parts, scarce needs explanation, as the very essence of this power consists in augmenting the consciousness of impressions received, and so increasing their influence. Thus we are inconscious of the ticking of a clock which is constantly in the room, or of the impression of the clothes we wear, unless our attention be particularly called to them, and then they become perceptible.

To appreciate justly the power of attention, it must be observed, that this, like other acts of the mind, may be voluntary or involuntary; the former being simply an intellectual operation, and devoid of perceptible emotion; the latter, the spontaneous impulse of feeling, and often beyond the control of the will.

But if this act of attention, which, is purely intellectual and voluntary, without perceptible emotion, be capable of

augmenting the force of impressions, by increasing consciousness; far more is this the case when it results from feeling, and is involuntary, appertaining to the nature of a passion: as when the sight of a painful operation causes the spectator to shudder by turning his attention inwards to his own feelings.

This then is the mode of attention, inconsciously and involuntarily excited, which is here alluded to, as fixing the energy of the mind more strongly on particular organs, thus varying the degree of nervous influence exerted upon them, and altering their action or condition.

In what manner the attention is inconsciously fixed upon particular parts is to be sought for in the nature of each individual instance, as seen in the following examples.

Hearing another cough vehemently and frequently, fixes the mind so strongly upon the feelings in the throat, as to produce at length a change of circulation, and occasion a sense of tickling and propensity to cough likewise. Seeing another yawn, inconsciously fixes the attention so as to awaken a sense of weariness in the jaws, that disposes the observer to yawn also. Thinking of grateful food, on the same principle, alters the action of the secreting vessels, and increases the flow of saliva into the mouth. The flow of milk is increased in the same way, and often commences before the infant actually touches the breast of the mother. A blush may be excited by looking stedfastly and suspectingly in a person's face. The attention thus strongly directed to the feelings of the face, alters the action of its vessels, and produces the change in question. The senses of hunger and thirst may be brought on or accelerated by thinking of them; and the desire of evacuating the bladder or rectum, by circumstances accidentally directing the attention to feelings otherwise too slight to have been noticed. Bodily fatigue comes on much sooner when the sameness and dreariness of the road we travel continually reminds us of the distance we have already gone, and awakens a sense of the disparity between our strength and the effort still to be made. The sense of drowsiness, or mental weariness, is liable to be brought on in the same way by the prospect of a long story, and the anticipation of the fatiguing

effort required to listen to it. In short, it is needless to multiply instances which will spontaneously occur to every one's recollection.

The truth of the principle, that these and similar phenomena depend upon the influence of increased attention to particular feelings thus augmenting their force, is not less evident in the converse of this proposition, or in the operation of causes which divert the attention from these feelings, and thus diminish or suspend their influence. A few instances will serve to illustrate this point.

Every one must have experienced how much uneasy sensations are alleviated by any thing that engages the mind and withdraws the attention. Head-ache and tooth-ache have been often removed by the receipt of agreeable news or the welcome arrival of an unexpected friend. The chess board has been found to alleviate the pains of gout; and an attack of spasmodic asthma has been suspended by strongly engaging the attention. Sudden alarm has been known to stop the paroxysm of an ague and check the operation of an emetic. The practice of taking away the hiccough, or preventing a person from sneezing, by strongly fixing the attention, is familiar to every one; and let a cough be ever so troublesome, it is commonly suspended while we are eating, the impression in the mouth and fauces suspending the influence of that in the larynx. The beneficial effect of sucking lozenges appears referable to their power of abstracting the attention from one impression by substituting another.

Thus another class of phenomena resolves itself in the same way as those before enumerated; and like the effects ascribed to sympathy and imitation, may be accounted for without multiplying causes, or resorting to the invention of more principles.

The extensive influence which the mind exerts over the involuntary functions, is conspicuous in them all; and considering each organ in the animal frame as forming part of a sentient being, its participation in mental impressions, in all cases, ultimately proceeds from different modifications of one general principle, or change of feeling causing change of action.

Art. VI. *On the Strata of a remarkable Chalk Formation in the Vicinity of Brighton and Rottingdean. By* J. F. Daniell, *Esq. F.R.S. and M.R.I.*

In geological speculations the more we confine ouselves to the later changes which have impressed themselves upon the surface of our globe, the more probable appears the chance of our being able to ascend, by a connected chain, to first principles, and to elucidate causes from their effects. Many of the more recent modifications of our strata are obviously ascribable to agencies now in energetic action, and in others a little more remote, we trace in analogy what is wanting in actual experience. Thus we see the formation of new lands in the depositions of lakes and rivers, calcareous rocks and islands the products of animal secretions, and carbonaceous beds accumulating from the slow decay of the vegetable creation. From the action of the ocean upon the detached masses exposed to its unceasing power, we infer the agency of attrition upon beds of gravel, and we refer to the depositions of the ocean the marine exuviæ which load the upper strata of the earth, while we distinguish fresh-water formations by the relics which they inclose.

It is this proximity and comparative connection with present circumstances which renders the geology of chalk and its associated beds peculiarly instructive, and justifies any attempt to extend our knowledge of its characters by local observations. In this view of the subject the following pages may not be deemed uninteresting, as they record some hitherto unnoted combinations and positions which materially affect our hitherto received notions of the comparative ages of these upper formations.

The stratum on which the town of Brighton stands, consists of a bed of calcareous matter of loose texture, containing angular flints of a whitish-gray colour, and mottled. It somewhat resembles in places a bed of gravel, but the stones are not rounded or water-worn. On proceeding to the eastward this is seen resting upon a bed of shingles, or rounded stones of considerable size, varying from eight to ten feet in thickness. They consist chiefly of flint, but contain rounded masses of granite, slate, and

porphyry. They are in general strongly cemented together by stalactitical matter, being carbonate of lime well crystallised, and formed probably by the infiltration of water from the upper bed. It thus constitutes a hard breccia, which, in the large masses which lie upon the beach, resists all the force of the waves. It contains within it small beds of fine, white, loose sand. On proceeding further to the east, the upper stratum, which varies from eighty to an hundred feet in depth, is found to contain small pieces of chalk, and here and there large blocks of very hard silicious sandstone. About a mile from Brighton the upper beds of calcareous matter and shingles are seen resting upon chalk, which is of the usual texture, except just at its junction with the cemented shingles where it is considerably harder, and in fracture resembles the lime-stone of the Giant's Causeway in Ireland. It contains nodules and flattened veins of flint, the latter intersecting it in all directions from the horizontal to the perpendicular. Proceeding in the same direction, the chalk nodules in the upper bed become more abundant, and compact, and increase in size to the dimensions of blocks; and blocks of chalk now make their appearance also in the bed of shingles. The chalk at last becomes so abundant in the upper stratum that it puts on in parts completely the appearance of a chalk-cliff. The lower bed is however still divided from the upper by the stratum of shingles, which cuts off the veins of flint in the former. About half way between Brighton and Rottingdean the cliff presents some very curious and important particulars. The upper bed, which has been assuming by gradual degrees more and more the characters of chalk, is decidedly chalk, and towards the top contains two horizontal veins of thin flint. The bed of shingles suddenly contracts to the width of a few inches, but maintains its situation and characters uninterrupted. The lower bed of chalk is intersected by veins of flint, which here traverse the bed of shingles, and continue their course through the upper bed till they reach the horizontal veins before described. One of these is inclined to the horizon at an angle of about 45° and pursues its direction in a straight line through all the strata. In another instance two veins in the lower stratum, running at

the same angle in different directions, unite at the bed of shingles, and pass into the upper bed in one seam, preserving the inclination of the most easterly of the two. Plate VII. accurately represents these particulars. The upper section exhibits the first appearance of the chalk C under the bed of shingles B, and the calcareous bed A. The position of the blocks of sandstone and angular flints is depicted in the latter. The under section very well describes the gradual transition of the upper bed A into chalk, the chalk blocks in the bed of shingles B, and its gradual contraction and enlargement. The course of the flint veins *e. e. e.* both in the upper and under chalk-beds is also minutely described.

The face of the cliff which presents these interesting appearances, is between three or four hundred yards in extent, and the upper horizontal veins are continuous throughout it; besides many smaller veins inclined in various degrees. The characters of the upper and lower beds of chalk are all along very distinct, the latter being divided into much larger masses than the former, and apparently not so prone to crumble and weather. The disintegration of the former appeared to me of a peculiar kind, arising from a glossiness or polished appearance of some of the surfaces analogous to what is known in Derbyshire mines by the term of *slickensides*, and has in other places been observed in various rocks. This peculiarity is prevalent to a great extent, and is the cause of the slipping down of large extents of the cliff. The polish is quite superficial, and does not render the chalk in the least degree harder.

The upper chalk formation ends as it begins by passing gradually and imperceptibly into the calcareous soil, with loose flints before described: the veins of flint cease, and the bed of shingles again increases to its original depth of 8 feet. The three beds now continue uninterrupted to within a very short distance of Rottingdean, where within a few hundred yards of the landing place the bed of shingles abruptly terminates and the upper stratum again assumes the character of chalk. The place of the bed of shingles is taken by a bed of nodulous flint of considerable thickness, and very different from the thin flint veins which pervade the cliff in other parts. The chalk

continues for a very small space, and again passes gradually and imperceptibly into the loose calcareous bed. As the veins of flint enter this latter, they are slightly contorted and turned up, and suddenly cease, and the bed of shingles no more makes its appearance. The east side of the landing-place is like the west, composed of the calcareous bed, which continues a very short distance, it soon passing into the upper chalk formation. The veins of flint at their commencement on this side are waved and contorted as they are at their termination on the other. High chalk cliffs succeed, the upper beds of which are only distinguished from the lower by beds of nodulous flint. Veins of flint equally pervade both. The calcareous bed with flints again occurs to the east, succeeding the chalk by the same gradual and imperceptible gradation. Its junction with the lower chalk is here marked by a waved and deeply indented line clearly defined by the difference of colour. The flint veins are bent and turned up as they pass into it from the chalk, and on the east side they pervade it for a considerable length, being waved and distorted through their whole course. It again passes into and is succeeded by high chalk cliffs to the east. The upper section of Plate VIII. points out the cessation of the shingle-bed, and the succession of the bed of nodulous flint. The passage of the upper chalk formation into the calcareous bed on both sides, is also described, together with the contortion of the flint veins. The under section presents the high chalk-cliffs to the east of Rottingdean, with the intermediate calcareous bed and the waved and deeply-indented line of junction. The disturbance and contortion of the flint veins on their passage into the calcareous bed is more distinct here than in the former situation.

There are no indications of any dip in the strata in any part of this line of coast.

The lower chalk-beds contain iron-pyrites, echini, and nodules of flint, which are completely globular; and seams of an ochreous clay sometimes, but rarely, occupy the place of flint veins. But the most remarkable appearance is that of a kind of vein of marl running in a horizontal direction, which gives the chalk a striated or mottled look of a darker colour

than the chalk. This seam always cuts off the flint veins, which grow thinner as they approach it, and often run off to the thickness of a wafer. Here and there I observed the flint vein continued on both sides, and the place which it should have occupied in the centre, supplied with a red ochre. Nodules of deep red ochre of the shape of flints were sometimes observable in it, but flint never.

I shall not attempt to theorise upon the facts which I have endeavoured to describe, but shall conclude this paper by pointing out the peculiar features of the arrangement, and some obvious conclusions to which they seem to lead.

We can hardly refuse to acknowledge in this spot two very distinct chalk-formations, deposited in their present positions at a very long interval of time. The bed of shingles which separates them, and which is composed not merely of rounded flints but of worn fragments of the primitive rocks, if we suppose it the product of the agitation of waters, must have been ages in its accumulation. The upper bed, by its varying characters, its greater degree of disintegration, and the masses of sandstone which it here and there contains, would seem to have been the result of confused and disturbed deposition. It may be perhaps considered analogous to a chalk-bed at Handfast-point, Dosetshire, described by Mr. Webster in Sir H. Englefield's work upon the Isle of Wight.—"In the vertical strata, the chalk is far from being uniform in its texture; appearing as if formed by the union of masses of chalk of different qualities, some parts being denser than others, and rather of a darker colour. When large masses fall down they frequently separate into roundish fragments which have a lumpy and concrete appearance. It might be called a *Breccia-chalk*, composed of roundish lumps of a hard chalk cemented by a chalk somewhat softer."

But the most important consideration regards the flint veins which traverse the three beds. These must have been of later formation than the strata which they prevade, and their position would fix their production subsequent to the accumulation of an alluvial bed by the attrition of agitated water. It is also worthy of remark, that both in the upper and under chalk-beds,

whenever horizontal and inclined veins of chalk meet, the former continue their course uninterrupted, while the latter are *shifted* either to the right or the left.

The complete interruption of the flint veins also by the seams of marl is a curious fact, and one which I do not remember to have seen recorded. In some instances the iron and argillaceous earth, which enter into the composition of flint, occupy its place, but without any admixture of siliceous matter. The hardening of the chalk in particular positions is, I think, satisfactorily accounted for, by the infiltration of water holding carbonate of lime in solution, which is plainly enough indicated by the cementation of the shingles. This same cause may likewise, perhaps, explain analogous instances where less simple theories have been adopted.

These observations may appear minute, but if they are exact, as I have no doubt they will be found, it is from the combination of such that we may hope at last to solve the great problem of the structure of our globe.

A List of the substances collected in illustration of these remarks, and which are deposited in the collection of the Royal Institution, is subjoined.

No. 1. Specimens of the calcareous bed, shewing the small nodules of chalk and imbedded flints.

2. White and mottled flints from the calcareous bed.

3. Specimen of the calcareous bed, taken further to the east, where the chalk-nodules are indurated, larger, and more abundant.

4. Calcareous spar, forming the cement of the shingle-bed.

5. Granite-boulder from the shingle-bed.

6. Chalk hardened at the contact with the shingle-bed.

7. Specimen of chalk, the upper part of which is hard, and the lower soft.

8. Specimen of the marl-veins in chalk, which cut off the flint-veins.

9. Ochre from the marl-veins.

Art. VII. *Report of Mr.* Brande's *Lectures on Mineralogical Chemistry, delivered in the Theatre of the Royal Institution, in the Spring of* 1817. *Continued from page* 74.

I mentioned in my last Lecture that among the metals, some were found in a state of comparative purity, either in the bowels of the earth or in the beds of rivers and among alluvial strata, or soils: they are then at once fit for the purposes of the manufacturer, and only require a few of the simplest mechanical operations to be converted into ornamental or useful forms.

Again, there are others which are discovered in various states of mixture or combination, their properties are hidden and concealed, and they require to undergo several very important and intricate operations, either mechanical or chemical, before they can be applied to useful purposes, or even before they exhibit their real characters.

As might be expected, we find, on referring to history, that the metals earliest known, were gold and silver; that copper and iron, though discovered also at a remote period, are of a later date; and that the greater number of these bodies were brought to light by the industrious ignorance of the alchemist, or have been more recently discovered by the inquisitive and well directed industry of modern chemical philosophers. The ancients only knew seven metals, and we are now capable of distinguishing 33; of these, some were discovered during the dark ages, but the greater number have been more recently made known by contemporary chemists, and the existence of several has been demonstrated within the last ten years.

There are so many properties which are common to the metals as a class, and which in themselves are of such interest and importance as to induce me to give a short account of them, in order to save repetition of discussion and experiment in their subsequent individual examination.

The metals now known are 33, and may be arranged into three classes:

14 Malleable.

13 Brittle.

6 Highly oxidable and inflammable.

The earths, alumina, silex, glucine, zircon, and ittria, are also probably metallic oxides, but their bases have not yet been exhibited in an insulated state; it is, therefore, rather inferred than proved.

Among the mechanical characters of the metals, a peculiar lustre and perfect opacity belong to the whole class; they are also conductors of electricity, and among the best conductors of heat. The conducting powers of the metals, in regard to heat and electricity, is subject to much variation. Silver, gold, copper, and tin, conduct better than platinum, iron, steel, or lead. Metals, like other bodies, expand and contract by the agency of heat and cold. Platinum, gold, and iron, are the least expansible: silver, copper, and brass the most so. Mr. Children has communicated to the Royal Society some curious researches respecting the effect of electricity upon the different metals, from which he has inferred relative differences in their conducting powers. If a wire of gold and one of platinum be continuously united by hooking them together, and introduced into a proper electrical circuit, the platinum becomes ignited, but the gold is not affected;—now, as resistance to the passage of electricity is probably the cause of the ignition, it would seem that gold conducts better than platinum, platinum better than zinc, and gold and copper nearly equal.

The order of conducting powers, therefore, is silver, zinc, gold, copper, iron, platinum; and it deserves remark, that there is here a near agreement with their conducting powers in regard to heat. The metals, too, present some very singular electrical phenomena, upon which the construction of the Voltaic battery, and the phenomenon called Galvanism depend.

Tenacity, or very powerful aggregation of particles, is a quality belonging to many of the metals, and those possessed of it are malleable and ductile; that is, they may be beaten out into leaves and drawn into wire. Some of the metals are

brittle, others malleable and ductile at certain temperatures, and brittle at others. Gold may be taken as an instance of a very malleable metal, one grain being extensible over 56 square inches. Iron, though scarcely malleable, is very ductile, and so tenacious, that a wire $\frac{1}{10}$ of an inch diameter supports 800lbs without breaking; a wire $\frac{78}{100}$ of a line in diameter of

Copper supports	302 lbs
Platinum	274
Silver	187
Gold	150
Zinc	109
Tin	34
Lead	27.

When metals are exposed to heat they enter into fusion, and rise in vapour, but if air be excluded they undergo no other change; we have not been able to decompose or resolve into simpler forms of matter any one of the metals, we are consequently to regard them as elementary bodies, though there are some analogical grounds for believing that this is not really so. The temperatures at which they melt, or their points of fusion, are very various;

Mercury is fluid at all common temperatures,
Potassium fuses at 150° Fahrenheit.

Sodium	200
Arsenic	360
Tin	450
Lead	600
Zinc	700
Antimony	800

silver, gold, and copper, require a red heat; iron melts at a white heat; and platinum requires a more intense degree of ignition than our furnaces afford.

When the metals in a fused state are exposed to the action of air they exhibit very different characters. Some undergo no obvious change, they retain their clean and brilliant lustre, and when cooled, appear as exactly as before. Others, on the contrary, lose their metallic brilliancy, become tarnished, and seem gradually to be changed into a substance of an apparently

earthy nature; others again take fire, and during burning lose their metallic characters. The observation of these phenomena led the older chemists to talk of *noble* and *imperfect* metals; and one of the great theories of early chemical science was founded upon the apparent conversion of metals into earths. It was imagined that the metals were compounds, that they consisted of earths and phlogiston, and that when heat was applied the phlogiston flew off in the form of fire, leaving the earth or basis behind.

This idea of the composition of metals founded upon the phenomena of their combustion was cherished by the majority of chemists, till the theory of their science underwent that celebrated revolution which ended in the establishment of the antiphlogistic doctrines. Not that experimental evidence was deficient for its earlier subversion, but because men were in the habit of adhering to old opinions to save themselves the trouble of imbibing new ones which should modify the language and opinions that they had been taught from their youth. More recent examples of similar obstinacy are not wanting; and indeed the history of this science abounds in remarkable instances of persons blindly adhering to old and erroneous views, as well as of the opposite and equally mischievous mistake of men who grasp at every ephemeral opinion merely because it is new, and who vere about with every breeze that ripples the ocean of discovery.

When a semi-metal is heated in the fire, said Beccher, and the alchemists, and Stahl, it is decomposed, the earth which was one of its constituents remains in the crucible, and phlogiston, its other component part, flies off: thus it was imagined that all the metals consisted of earth and various portions of phlogiston; an hypothesis which doubtless was recommended by simplicity; but even this pretension was given up, on finding that the said earths left by the combustion of the metals were very dissimilar, and it became requisite to suppose as many different earths as there were metals. But in those foggy times of chemistry there lived a few masterly experimenters, and although the light of their researches was for a period confined to a small space, it ultimately burst

forth, and in a subsequent age tended to the vigorous expansion of the science.

I chiefly allude to Rey and Mayow. In 1629, Brun, an apothecary resident in the town of Bergerac in France, melted two pounds six ounces of tin, and in six hours the whole was changed into earth of tin, which, to his infinite surprise, weighed six ounces more than the metal he set out with. He consulted Rey, who was then a physician in Perigord, and who took up the inquiry with a diligence and accuracy which would be deemed uncommon in these days. His results he communicated as follows: "I answer, and gloriously maintain, that the increase of weight depends upon the union of air with the metallic earth:" he compares the effect to the moistening of sand with water. "I know," says he, "there are many whom this answer would affright, had it not been supported by the unanswerable proofs of experiment; and all those who deny the weight of the air will have risen up against me. What? do we not extract heat from cold, black from white, light from darkness, yes, and from so light a body as air, we derive so great an increase of weight. Thus I have succeeded in liberating this surprising truth from the deep dungeons of obscurity. Others may seek it, but they will search it in vain, unless they pursue the experimental path which I have cleared. The labour has been mine, the profit is to the reader, the glory from above." This language is in the true spirit of Lord Bacon's philosophy. Mayow, in 1674, deduced similar conclusions respecting the appearances of calcination; and in perusing the tracts of this keen and curious enquirer we cannot but be struck with the abundant anticipations of modern discoveries which they contain. In treating, for instance, of antimony, he observes, that its increase of weight in the fire evidently results from the fixation of the nitro-aërial particles of the atmosphere, a notion which was singularly verified after the lapse of a century by Dr. Priestley.

Against such evidence however the phlogistic hypothesis was still suffered to prevail, and it was not till past the middle of the last century, that chemists began to resign their old opinions, and to imbibe the doctrines set forth and embel-

lished by Lavoisier. Although it will be obvious that this celebrated luminary of chemical science shone rather with borrowed light than innate splendour, he was nevertheless of excellent service to the progress of chemistry, and conducted philosophers from the dark recesses of speculation to the luminous regions of experiment; he was gifted with indefatigable perseverance, zeal, and assiduity, and talents and fortune conspired to render him the most eminent promoter of chemistry whose name is upon record. I shall not claim for him the merits of originality as a theorist, for in all main points he was anticipated by Rey and Mayow; his great merit consisted in concentrating the dispersed hints and solitary experiments of his predecessors into a focus, which at once illuminated and enlivened the science. Lavoisier's generalizations were founded in a great measure upon the phenomena of metallic calcination set forth by Rey and Mayow, and his celebrated experiment upon the calcination of quicksilver was a mere variation of those previously devised and executed.

Lavoisier heated quicksilver in a confined portion of air, and found that the metal gained in weight just as much as the air lost; he thus found that it absorbed a principle of the atmosphere which he called *oxygen* gas, because it produces many *acid* compounds. He considered oxygen gas as consisting of a ponderable basis, united with the matter of heat and light, and maintained the necessity of its presence in all cases of combustion.

Led away by the inferences which these experiments suggested, Lavoisier extended the superstructure of his theory beyond what its foundations would bear, and consequently in a few years it began to totter and then to tumble. He indulged in hasty conclusions, instead of toiling with firm and cautious steps up the narrow tracks of demonstration. And thus by aspiring too high, missed that which by a less ambitious aim he might have gained. He attempted to dazzle where he could not convince, and insisted upon the decomposition of oxygen in every case of combustion, though fully aware of a host of instances directly opposed to such a conclu-

sion. The combinations of the metals with oxygen are an important and curious class of bodies, and previous to cultivating their nearer acquaintance it may be worth while shortly to consider their general characters. They are extremely numerous, for the greater number of metals unite with oxygen in more than one proportion, and consistent with the beautiful laws of combination lately developed, the second or other proportions of oxygen are multiples of the first: Thus

100 Mercury + 4 + 8 Oxygen
100 Copper + 12 + 24 Do.
100 Lead + 8 + 12 + 16 Do.

The metallic oxides are of various colours, and generally specifically lighter than the metals, which form their basis; they have no smell, and mostly no taste. Some have no action on vegetable blues; others redden them, and some convert them to green.

The method of effecting the oxidyzement of the different metals varies; some, as lead, antimony, &c. are oxidyzed by the joint action of heat and air, others by the acids and water, as zinc, iron, &c. The quantity of hydrogen in these cases evolved, becomes the indicator of that of oxygen tranferred; one part by weight of hydrogen indicating 7,5 of oxygene. So that the production of 100 cubic inches of hydrogen announce the transfer of seventeen grains of oxygen to the metal.

The oxides dissolve in acids without the evolution of hydrogen. They retain oxygen with very different powers, as shewn by oxide of mercury being decomposed by iron, oxide of lead by potassium, &c.

Some, as oxide of mercury, lose all oxygen by heat, others only a part, as oxide of manganese. Those metals which retain oxygen most greedily are the most eager of its acquisition, as shewn in the oxide of potassium, of sodium, and in the white oxide of manganese.

The metallic oxides are bodies of as much importance as the metals themselves, and are used very largely in many of the arts; and in medicine. So that their relations to other bodies and the various resulting compounds, will require more

minute and extended consideration under the heads of the separate metals.

There are another series of metallic compounds,—the *Chlorides*, which, though of less general interest than the oxides, are still of consequence. Chlorine unites to all the metals, and generally its attraction for them exceeds that of oxygen, so that oxides of mercury, of lead, &c. heated in chlorine, evolve oxygen and afford chlorides of their respective metals; copper, antimony, potassium, and some other metals, burn spontaneously when thrown into chlorine.

Such are some of the most important facts in regard to the general properties of the metals and their compounds with the simple supporters of combustion. In their combinations with combustibles, we have still a class of bodies of much use and interest, and in uniting to each other to produce *alloys*, they frequently attain new qualities fitting them for a variety of purposes to which they are individually inapplicable.

In noticing the metals individually, I propose, consistently with the plan formerly pointed out, to consider them first as natural products, and to notice the various states of combination in which they thus occur; we may then advert to the methods of separating them from their ores, and of rendering them fit for the purposes of the arts. To this will succeed an account of their chemical characters, upon which the processes of analysis must of course depend, and of such of their compounds as are useful in the arts.

Gold is one of the few metals only found native, and in this state is easily recognised by colour, malleability, &c; it is found crystallized, filamentous, and disseminated in rounded lumps of various sizes in alluvial soils.

Geologists consider gold as one of the most ancient of the metals, for it is invariably found in primitive rocks. Its gangue is quartz, calcareous spar, felspar, carbonate of lime, and sulphate of barytes. Africa and America are the richest countries in gold. In Africa it always occurs in the beds of rivers and in the alluvial soils of the plains, either in small grains or in masses of different sizes. The principal tracts rich in this

precious metal are in the western part of Africa, to the south of the great desert of Zara, and between Darfur and Abyssinia; and the sands of the Gambia, Niger, and Senegal, are all auriferous; it is supposed that Ophir, whence Solomon obtained gold, was a country on the S.E. coast; and Herodotus relates, that when the messengers of Cambyses waited upon the king of Ethiopia, they were shewn the prisoners bound in chains of gold. As this metal is found in a ductile tenacious, and workable state, it is almost the only one employed by savage nations, and various ornaments and utensils are frequently made of it. These untutored tribes have always regarded the eagerness of their European invaders to obtain it with the utmost astonishment; of this the history of America furnishes us with many curious instances. In one of the early incursions into the interior of that continent, the Spaniards contested with such eagerness about the division of some gold, that they were on the point of proceeding to acts of mutual violence, when a young Cazique, who was present, tumbled it out of the balance with indignation, and turning to the invaders, "Why," said he, "do you quarrel about such a trifle: if it be for gold that you abandon the regions of your fathers, and disturb the peaceful tranquillity of these distant nations, I will conduct you to a region abundant in this mean object of your admiration and desire." The thirst for gold was the principal incentive to the almost more than human enterprises performed by the followers of Columbus. Animated by the certain prospect of gain, they pursued discovery with greater eagerness than when excited only by curiosity and hope. The riches of Peru, Mexico, and Brasil are well known, and the gold is there principally found in the beds of rivers, although *veins* have likewise been successfully worked.

Asia cannot at present be deemed rich in gold, although it has been found in Ceylon, Borneo, Sumatra, and some of the Archipelago islands. Of the abundance of gold which once enriched the Pactolus we now know nothing.

Nor can Europe boast of golden treasures. According to Diodorus Siculus, and Pliny, the Phenicians and Romans

procured considerable quantities of gold from Spain. The poets, too, found it in the sands of the Tagus. In France it has been found in the department of the Isere in the Rhone, at its junction with the Arau; in the Rhine near Strasburgh and Germersheim, but neither above nor below it, and in the Garonne near Toulouse. In Piedmont in the vallies at the foot of mount Rosa, and of the Simplon; and also in the small streams that intersect the red alluvion about Chivasso. The only important gold mines of Europe are those of Hungary.

The metallurgic processes for obtaining gold from its ores are sufficiently simple. They are broken in the stamping mill and washed, by which the lighter and earthy parts are separated: they are then submitted to the action of mercury, which dissolves the gold, which is afterwards obtained by distillation.

Gold is a yellow metal of a specific gravity of 19. It melts at a red heat; Even at very high temperatures, oxygen has little action upon it; it burns into a purple powder by the action of electricity, which is an oxide of gold. Chlorine instantly acts upon gold, and forms with water a muriate. Hence gold, though insoluble in nitric and muriatic acids separately, is soluble in their mixture. This is a yellow soluble salt.

The muriate of gold is characterised by assuming a purple colour when exposed on paper to the sun's rays, by affording with potash a dingy yellow precipitate, and a detonating precipitate with ammonia Sulphate of iron throws down the gold in the state of a fine powder, used sometimes in gilding porcelain, and a fine purple is obtained for the purpose of porcelain painting by adding muriate of tin to muriate of gold. It is called the purple of Cassius.

The permanence and beauty of gold renders it a very desirable ornament, while at the same time its extensibility enables us to use it where its expense and weight would otherwise preclude its employment. Where gilding is performed upon metallic surfaces it is usually done by a solution or amalgam of gold in quicksilver. This is called water gilding,

and the process exhibits an instance of chemical attraction, and subsequent decomposition by heat. Steel is sometimes gilded by the ethereal solution of gold.

Silver is not only found native, but likewise in various states of combination; it therefore furnishes a more numerous series of ores than gold.

Native silver occurs crystallized and in a variety of other forms, it is malleable, and enjoys most of the characters of the pure metal; it usually contains traces of antimony, copper, or arsenic, and, like gold, its principal veins are in primitive mountains.

Kongsbergh in Norway, Schlangenberg in Siberia, Andreasberg in the Hartz, are mines whence large quantities of native silver have been drawn; it has been found in Cornwall and in Scotland. In 1666 a mass was found in Norway weighing 560lbs. And in 1478, Duke Albert of Saxony descended into one of the Schneeberg mines, and used as a dining table a block of silver weighing nearly 20 tons. But the quantity of silver found in various parts of America far exceeds that of the old world; and the earlier visitors of Mexico and Peru saw in the possession of the natives such abundance of this metal, obtained by little industry and less skill, as induced them to hope for inexhaustible stores, as the recompense of more intelligent and persevering efforts. In 1545 the rich silver mines of Potosi were, according to Fernandez, accidentally discovered by an Indian clambering up a mountain in search of a lama that had strayed from his flock, and shortly after, the equally valuable mines of Sacotecas in New Spain were opened. Since that period the working of silver mines is greatly increased, and the evidence of modern travellers concerning the profusion of their produce is such as to astonish an inhabitant of the ancient hemisphere. It is difficult to form an e timate of the exact produce in silver of the mines of the New World, but we know that it has been greatly on the increase, and that the precious metals have altogether become more common in Europe. It has been supposed that such are the treasures of those mines, that if properly worked such

quantities of silver would be obtained as to shake our commercial system by its abundance.

Besides native silver and its alloy with gold we have several other important ores, of which antimonial, arsenical, and sulphuretted silver are the principal.

Antimonial silver is a soft sectile and white ore, and when crystallized is in four and six-sided prisms. It consists of 78 silver and 22 antimony. Before the blowpipe it exhales oxide of antimony and leaves pure silver.

Arsenical silver is more gray than the former; harder, and rather brittle. It is crystallized in small four-sided prisms. It exhales a garlic smell before the blowpipe, and leaves impure silver. A specimen from Andreasberg analysed by Klaproth, gave

Arsenic - -	35
Iron - - -	44
Silver - -	13
Antimony - -	4

Another yielded me

Arsenic - -	30
Iron - - -	20
Silver - -	28
Antimony -	20

The native compounds of sulphur and silver are numerous and important. The brittle sulphuret contains about 72 per cent. of sulphuret of silver, 10 antimony, and 10 iron, copper, and arsenic. One of the most beautiful ores of silver is the red or ruby silver, crystallized in six-sided prisms and their modifications. It is a compound of silver, antimony, and sulphur, and is well marked by decrepitating before the blowpipe, exhaling antimony and sulphur, and leaving a globule of pure silver; its component parts are

Silver - -	60
Antimony - -	20
Sulphur -	20

The mines of Kongsberg, Schemnitz, and the Hartz, have furnished exquisite specimens of this ore; it also constitutes a great part of the riches of the Mexican mines.

These are the principal ores of silver which we recognize in the cabinet of the mineralogist, and they are the prolific though by no means the only sources of the metal, for large quantities of silver are likewise procured from other ores, in which it constitutes a very small relative proportion, consequently they remain for after consideration.

In extracting the silver from the ores that contain it native, they are either fused with lead, and cupelled, which is the modern method, or they are triturated with quicksilver, which forms an amalgam. This is a very ancient process, and was first employed in the Mexican and Peruvian mines, by Pedro Velasco in 1566. The less pure ores may be roasted with common salt, and put into tubs with mercury, iron plates, and water. Muriate of iron and amalgam is formed.

The assay of a silver ore to ascertain the quantity of precious metal, is easily performed. The ore in fine powder may be digested in dilute nitric acid, the solution filtered, and mixed with solution of common salt, the precipitate is chloride of silver, of which 100 parts, when dry, indicate 75 of metal; or the chloride may be reduced by fusion with three parts of subcarbonate of soda.

Pure silver is a white metal of much lustre, and having a specific gravity of 10,5. It melts in a bright red heat. It combines in one proportion only with oxygen.

	100	S.
	7,5	O.
	107,5	Oxide of silver.
The chloride contains,	100	S.
	33,5	C.
	133,5	Chloride of silver.

Nitric acid is the readiest solvent of silver, and when the solution is evaporated it gives crystals, which fused and run into moulds produce *lunar caustic.*

This salt is possessed of some curious properties; it is decomposed by the action of light and by phosphorus, hydrogen,

charcoal, sulphur, and several of the metals. The silver is precipitated in a beautiful arborescent form by quicksilver, forming the arbor Dianæ.

When a solution of 40 grs. of silver in 2 oz. of nitric acid diluted with 2 oz. of water, is heated with 2 oz. of alcohol, a white powder precipitates, which is fulminating silver. It detonates when gently heated or rubbed. Its composition is not exactly known.

All substances containing chlorine, consequently all the muriatic salts, furnish an insoluble chloride of silver when added to the soluble compounds of that metal. Hence in analytic chemistry, the use of silver as a test for muriatic acid and *vice versa.*

The quantity of the precious metals annually raised from the mines amounts to about $10\frac{1}{2}$ millions sterling, of which $2\frac{1}{2}$ million is in gold, and 8 in silver.

Of the gold 2,300,000 is from America, and about 200,000 from Europe, Asia, and Africa. Of the silver, 7 million is the produce of America, and the remainder of the other quarters of the world.

A luminous view of the relative value of gold and silver has been given by Lord Liverpool in his letter on coins. According to the regulations of the Mint, a pound troy of standard gold consists of eleven ounces of pure gold and one ounce of pure copper, twenty pounds troy of this alloy is coined into 934 sovereigns, and one half sovereign. One pound used to afford $44\frac{1}{2}$ guineas; it now produces $46\frac{29}{40}$ sovereigns.

The pound troy of standard silver consists of eleven ounces two pennyweights pure silver, and eighteen pennyweights of copper, and is coined into 66 shillings.

In the time of Herodotus and Plato, that is, about 450, and 400 years before the Christian era, the relative value of gold and silver in Persia and Greece was as 13 and 12 to 1; and in Rome, about 189 years B. C. it was as low as 10 to 1; and when Cæsar returned loaded with the spoils of Gaul, such was the abundance of gold that it became as low as $7\frac{1}{12}$ to 1. About a century afterwards it advanced to about $12\frac{1}{2}$

to 1. In the reign of Constantine it fell to $10\frac{1}{2}$; and about 80 years afterwards we find it 14,5 to 1.

Accordingly in ancient times the lowest relative value was as $7\frac{1}{2}$ to 1; the highest 14,5 to 1, which is not greatly different from the relation now existing. The cause of these fluctuations offers a very curious inquiry, but it belongs to the political œconomist rather than the chemical philosopher.

Art. VIII. *On the Greenland or Polar Ice.* By William Scoresby, *jun. M. W. S.*

Mr. Scoresby's paper was read at the Wernerian Society, March 1815, and will appear in the forth-coming volume of the Transactions. The part of the volume of the Transactions containing this paper has been printed, and a considerable part of it has been inserted in the *Annales de Chimie.* Under these circumstances we have not thought it improper to lay before our readers extracts from this interesting performance, recommending at the same time to all, the perusal of the entire paper.

Of the inanimate productions of Greenland, none perhaps excites so much interest and astonishment in a stranger, as the *Ice* in its great abundance and variety, The stupendous masses known by the names of *Ice-Islands, Floating-Mountains,* or *Icebergs,* common to Davis's Straits, and sometimes met with here, from their height, various forms, and the depth of water in which they ground, are calculated to strike the beholder with wonder: yet the *fields** of ice, more peculiar to Greenland, are not less astonishing. Their deficiency in elevation is sufficiently compensated by their amazing extent of surface. Some of them have been observed near a hundred miles in length, and more than half that breadth; each consisting of a single sheet of ice, having its surface raised in

* A *field* is a continued sheet of ice, so large, that its boundaries cannot be seen from the summit of a ship's mast.

general four or six feet above the level of the water, and its base depressed to the depth of near twenty feet beneath.

The best mode of explaining the terms in common acceptation amongst the whale fishers will be by marking the disruption of a field. The thickest and strongest field cannot resist the power of a heavy swell. When a field, by the set of the current, drives to the southward, and being deserted by the loose ice, becomes exposed to the effects of a *grown* swell, it presently breaks into many pieces, few of which will exceed forty or fifty yards in diameter. Such a number of these pieces closely collected together, so that they cannot, from the top of the ship's mast, be seen over, are termed a *pack.*

When the collection of pieces can be seen across, if it assume a polygonal form, the name of *patch* is applied, and it is called a *stream* when its shape is more of an oblong, how narrow soever it may be, provided the continuity of the pieces is preserved.

Pieces of very large dimensions, but smaller than fields, are called *floes.*

Small pieces which break off, and are separated from the larger masses by the effect of attrition, are called *brash-ice,* and may be collected into streams or patches.

Ice is said to be *loose* or *open,* when the pieces are so far separated as to allow a ship to sail freely amongst them ; this has likewise been called *drift-ice.*

A *hummock* is a protuberance raised upon any plane of ice above the common level. It is frequently produced by pressure, where one piece is squeezed upon another, often set upon its edge, and in that position cemented by the frost. They occur in great numbers in heavy packs, on the edges and occasionally in the middle of fields and floes. They often attain the height of thirty feet or upwards.

A *calf* is a portion of ice which has been depressed by the same means as a hummock is elevated. It is kept down by some larger mass ; from beneath which, it shews itself on one side.

Any part of the upper superficies of a piece of ice, which

comes to be immersed beneath the surface of the water, obtains the name of a *tongue.*

A *bight* signifies a bay or sinuosity on the border of any large mass or body of ice.

When the sea freezes, the greatest part of the salt it contains is deposited, and the frozen spongy mass probably contains no salt, but what is natural to the sea-water filling its pores. As, however, the ice frozen from sea-water does not appear so solid and transparent as that procured from snow or rain-water, sailors distinguish it into two kinds, accordingly as it seems to have been formed from one or the other.

When *salt-water ice* floats in the sea at a freezing temperature, the proportion above, to that below the surface, is as 1 to 4 nearly; and in fresh water, at the freezing point, as 10 to 69, or 1 to 7 nearly. Hence, its specific gravity appears to be about 0.873. Of this description is all *young* ice, as it is called, which forms a considerable proportion of packed and drift ice; in general it occurs in flat pieces commonly covered with snow of various dimensions, but seldom exceeding fifty yards in diameter.

Fresh-water ice is distinguished by its black appearance when floating in the sea, and its beautiful green hue and transparency when removed into the air. Fresh-water ice is fragile, but hard; the edges of a fractured part are frequently so keen as to inflict a wound like glass.

The most dense kind of ice, which is perfectly transparent, is about one-tenth specifically lighter than sea-water at a freezing temperature. Plunged into pure water, of temperature 32°, the proportion floating above to that below the surface, is as 1 to 15, and placed in boiling fresh water, it barely floats. Its specific gravity is about 0.937. Fields, bergs, and other large masses chiefly consist of fresh-water ice. *Brash-ice* likewise affords pieces of it, the surfaces of which are always found crowded with conchoidal excavations when taken out of the sea. Some naturalists have been at considerable pains to endeavour to explain the phenomena of the progressive formation of the ice in high latitudes, and the derivation

of the supply, which is annually furnished, for replacing the great quantities that are dissolved and dissipated by the power of the waves, and the warmth of the climate into which it drifts. It has frequently been urged, that the vicinity of land is indispensable for its formation.

I have noticed, observes Mr. Scoresby, the process of freezing from the first appearance of crystals, until the ice had obtained a thickness of more than a foot, and did not find that the land afforded any assistance or even shelter, which could not have been dispensed with during the operation. It is true, that the land was the cause of the vacancy or space free from ice, where this new ice was generated; the ice of older formation had been driven off by easterly winds, assisted perhaps by a current; yet this new ice lay at the distance of twenty leagues from Spitsbergen. But I have also seen ice grow to a consistence capable of stopping the progress of a ship with a brisk wind, even when exposed to the waves of the North Sea and Western Ocean, on the south aspect of the main body of the Greenland ice, in about the seventy-second degree of north latitude.

Freezing of the Ocean in a rough Sea.—The first appearance of ice whilst in the state of detached crystals, is called by the sailors *sludge*, and resembles snow when cast into water that is too cold to dissolve it. This smooths the ruffled sea, and produces an effect like oil in stilling the breaking surface. These crystals soon unite, and would form a continuous sheet, but, by the motion of the waves, they are broken into very small pieces, scarcely three inches in diameter. As they strengthen, many of them coalesce and form a larger mass. The undulations of the sea still continuing, these enlarged pieces strike each other on every side, whereby they become rounded, and their edges turned up, whence they obtain the name of *pancakes;* several of these again unite, and thereby continue to increase, forming larger *pancakes,* until they become perhaps a foot in thickness, and many yards in circumference.

Freezing of the Sea in sheltered Situations.—When the sea is perfectly smooth, the freezing process goes on more regularly, and perhaps more rapidly. The commencement is similar to that just described; it is afterwards continued by

constant additions to its under surface. During twenty-four hours keen frost, it will have become two or three inches thick, and in less than forty-eight hours time, capable of sustaining the weight of a man. This is termed *bay-ice*, whilst that of older formation is distinguished into *light* and *heavy* ice; the former being from a foot to about a yard in thickness, and the latter from about a yard upwards.

It is generally allowed, that all that is necessary in low temperatures for the formation of ice, is still water: here then it is obtained. In every opening of the ice at a distance from the sea, the water is always as smooth as that of a harbour; and as I have observed the growth of ice up to a foot in thickness in such a situation, during one month's frost, the effect of many years we might deem to be sufficient for the formation of the most ponderous fields.

There is no doubt but a large quantity of ice is annually generated in the bays, and amidst the islands of Spitsbergen: which bays, towards the end of summer, are commonly emptied of their contents, from the thawing of the snow on the mountains causing a current outwards. But this will not account for the immense fields which are so abundant in Greenland. These evidently come from the northward, and have their origin between Spitsbergen and the Pole.

On the Generation of Fields.—As strong winds are known to possess great influence in drifting off the ice, where it meets with the least resistance, may they not form openings in the ice far to the north, as well as in latitudes within our observation? Notwithstanding the degree in which this cause may prevail, is uncertain, yet of this we are assured, that the ice on the west coast of Spitsbergen, has always a tendency to drift, and actually does advance in a surprising manner to the south or south-west; whence, some vacancy *must* assuredly be left in the place which it formerly occupied. These openings, therefore, may be readily frozen over, whatever be their extent, and the ice may in time acquire all the characters of a massy field.

It must, however, be confessed, that from the density and transparency of the ice of fields, and the purity of the water

obtained therefrom, it is difficult to conceive that it could possess such characters if frozen entirely from the water of the ocean;—particularly as young ice is generally found to be porous and opaque, and does not afford a pure solution.

It appears from what has been advanced, that openings must occasionally occur in the ice between Spitzbergen and the Pole, and that these openings will, in all probability, be again frozen over. Allowing, therefore, a thin field, or a field of bay-ice to be therein formed, a superstructure may probably be added by the following process. The frost, which constantly prevails during nine months of the year, relaxes towards the end of June, or the beginning of July, whereby the covering of snow, annually deposited to the depth of two or three feet on the ice,* dissolves. Now, as this field is supposed to arise amidst the older and heavier ice, it may readily occupy the whole interval, and be cemented to the old ice on every side; whence the melted snow has no means of escape. Or, whatever be the means of its retention on the surface of the young field, whether by the adjunction of higher ice, the elevation of its border by the pressure of the surrounding ice, or the irregularity of its own surface, several inches of ice must be added to its thickness on the returning winter, by the conversion of the snow-water into solid ice. This process repeated for many successive years, or even ages, together with the enlargement of its under-side from the ocean, might be deemed sufficient to produce the most stupendous bodies of ice that have yet been discovered; at the same time that the ice thus formed, would doubtless correspond with the purity and transparency of that of fields in general.

Fields may sometimes have their origin in heavy close *packs*, which being cemented together by the intervention of new ice, may become one solid mass. In this way are produced such fields as exhibit a rugged *hummocky* surface.

* That snow is deposited on the ice in high northern latitudes is here allowed, because no field has yet been met with which did not support a considerable burthen of it.

Fields commonly make their appearance about the month of June, though sometimes earlier; they are frequently the resort of young whales; strong north and westerly winds expose them to the Greenlandmen, by driving off the loose ice. Some fields exhibit a perfect level plain, without a fissure or hummock, so clear indeed, that I imagine, upon one which I saw, a coach might be driven a hundred miles in a direct line, without any obstruction. Most commonly, however, the surface contains some hummocks, which somewhat relieve the uniformity of intense light, by a tinge of delicate green, in cavities where the light gains admittance in an oblique direction, by passing through a portion of ice.

The invariable tendency of fields to drift to the south-westward, even in calms, is the means of many being yearly destroyed. They have frequently been observed to advance a hundred miles in this direction, within the space of one month, notwithstanding the occurrence of winds from every quarter. On emerging from amidst the smaller ice, which before sheltered them, they are soon broken up by the swell, are partly dissolved, and partly converted into drift ice. The places of such, are supplied by others from the north.

On the tremendous Concussions of Fields.—The occasional rapid motion of fields, with the strange effects produced on any opposing substance, exhibited by such immense bodies, is one of the most striking objects this country presents, and is certainly the most terrific. They not unfrequently acquire a rotatory movement, whereby their circumference attains a velocity of several miles per hour. A field, thus in motion, coming in contact with another at rest, or more especially with a contrary direction of movement, produces a dreadful shock. The weaker field is crushed with an awful noise; sometimes the destruction is mutual: pieces of huge dimensions and weight, are not unfrequently piled upon the top, to the height of twenty or thirty feet, whilst doubtless a proportionate quantity is depressed beneath. The view of those stupendous effects in *safety*, exhibits a picture sublimely grand; but where there is danger of being overwhelmed, terror and dismay must be the predominant feelings

"On arriving at the point of collision," observes Mr. S., in describing the meeting of two immense bodies of ice, "I discovered, that the two points had but recently met; that already a prodigious mass of rubbish had been squeezed upon the top, and that the motion had not abated. The fields continued to overlay each other with a majestic motion, producing a noise resembling that of complicated machinery, or distant thunder. The pressure was so immense, that numerous fissures were occasioned, and the ice repeatedly rent beneath my feet. In one of the fissures, I found the snow on the level to be three and a half feet deep, and the ice upwards of twelve. In one place, hummocks had been thrown up to the height of twenty feet from the surface of the field, and at least twenty-five feet from the level of the water; they extended fifty or sixty yards in length, and fifteen in breadth, forming a mass of about two thousand tons in weight. The majestic unvaried movement of the ice,—the singular noise with which it was accompanied,—the tremendous power exerted,—and the wonderful effects produced, were calculated to excite sensations of novelty and grandeur, in the mind of even the most careless spectator!

Sometimes these motions of the ice may be accounted for. Fields are disturbed by currents, the wind, or the pressure of other ice against them. Though the set of the current be generally towards the south-west, yet it seems occasionally to vary: the wind forces all ice to leeward, with a velocity nearly in the inverse proportion to its depth under water; light ice consequently drives faster than heavy ice, and loose ice than fields: loose ice meeting the side of a field in its course, becomes deflected, and its re-action causes a circular motion of the field. Fields may approximate each other, from three causes: first, if the lighter ice be to windward, it will, of necessity, be impelled towards the heavier: secondly, as the wind frequently commences blowing on the windward side of the ice, and continues several hours before it is felt a few miles distant to leeward, the field begins to drift, before the wind can produce any impression on ice, on its opposite side; and, thirdly, which is not an uncommon case, by the two fields

being impelled towards each other, by winds acting on each from opposite quarters.

The closing of heavy ice, encircling a quantity of bay-ice, causes it to run together with such force, that it overlaps wherever two sheets meet, until it sometimes attains the thickness of many feet. Drift-ice does not often coalesce with such a pressure, as to endanger any ship which may happen to be beset in it: when, however, land opposes its drift, or the ship is a great distance immured amongst it, the pressure is sometimes alarming.

Icebergs. —The term icebergs has commonly been applied to those immense bodies of ice, situated on the land, " filling " the valleys between the high mountains," and generally exhibiting a square perpendicular front towards the sea.

Large pieces may be separated from those icebergs in the summer season, when they are particularly fragile, by their ponderous overhanging masses, overcoming the force of cohesion; or otherwise, by the powerful expansion of the water, filling any excavation or deep-seated cavity, when its dimensions are enlarged by freezing, thereby exerting a tremendous force, and bursting the whole asunder.

Pieces thus, or otherwise detached, are hurled into the sea with a dreadful crash; if they are received into deep water, they are liable to be drifted off the land, and, under the form of *ice-islands*, or *ice-mountains*, they likewise still retain their parent name of *icebergs*. Mr. Scoresby, however, doubts, if all the floating *bergs* seen in the seas west of Old Greenland, thus derive their origin; their number is so great, and their dimensions so immense, and has suggested the probability of *icebergs* being found at a distance from any known land.

We have been able, on account of our limits, to furnish but an imperfect view of the statements of Mr. Scoresby regarding the formation of the polar ice. The following, however, are his conclusions, and which will partly apply to the formation of the ice in other places of the polar circle:

I. *Drift ice.*—That the *light* packed or drift ice is the annual product of the bays of Spitzbergen, and of the interstices in the body

of older ice; and, that it is wholly derived from the water of the ocean.

That the *heavy* packed or drift ice generally arises from the disruption of fields.

II. *Icebergs.*—That some ice mountains or icebergs are derived from the icebergs generated on the land between the mountains of the sea coast, and are consequently, the product of snow or rain water.

That a more considerable portion may probably be formed in the deep-sheltered bays abounding on the east coast of Spitzbergen. These have their bed in the waters of the ocean, and are partly the product of sea-water, and partly that of snow and rain water. And it is highly probable,

That a continent of ice mountains may exist in regions near the Pole, yet unexplored, the nucleus of which may be as ancient as the earth itself, and its increase derived from the sea and atmosphere combined.

III. *Fields.*—That some fields arise from the cementation, by the agency of frost, of the pieces of a closely aggregated pack, which may have consisted of light or heavy ice; and consequently, which may have been wholly derived from the ocean, or from the sea and atmosphere combined.

That the most considerable masses are generated in openings of the far northern ice, produced by the constant recession towards the south of that body lying near the coasts of Spitzbergen; and, that such fields are at first derived from the ocean, but are indebted for a considerable portion of superstructure, to the annual addition of the whole, or part, of their burthen of snow. And,

IV. As to the *ice in general.*—That however dependent the ice may have been on the land, from the time of its first appearance, to its gaining an ascendancy over the waves of the ocean, sufficient to resist their utmost ravages, and to arrest the progress of maritime discovery, at a distance of perhaps from six hundred to a thousand miles from the Pole, it is now evident, That the proximity of land is not essential, either for its existence, its formation, or its increase.

On the Situation of the Polar Ice, and the Effects produced on it by the change of seasons.—The mass of ice lying between *Old* Greenland on the west, and the Russian portion of Europe on the east, though varying considerably in particulars, yet has a general outline strikingly uniform.

On the east coast of West Greenland, a remarkable alteration has, however, taken place. That part extending from the parallel of Iceland to Staten-Hook, was, before the fifteenth century, free of ice, and could always be approached in the summer season, without hinderance. After a considerable trade had been carried on between Iceland and the Main for upwards of 400 years, singular, as it may appear, of a sudden the polar ice extended its usual limits, launched down by the land to the Southern Cape, and so completely barricadoed the whole of the eastern coast, that it has not since been accessible.

This icy barrier, at present, with each recurring spring, exhibits the following general outline. After doubling the southern promontory of Greenland, it advances in a north-eastern direction along the east coast, enveloping Iceland as it proceeds, until it reaches John Mayne's Island.* Passing this island on the north-west, but frequently enclosing it likewise, it then trends a little more to the eastward, and intersects the meridian of London in the 71st or 72d degree of latitude. Having reached the longitude of 6, 8, or perhaps 10 degrees east, in the 73d or 74th degree of north latitude, it suddenly stretches to the north, sometimes proceeding on a meridian to the latitude of 80°, at others forming a deep sinuosity, extending two or three degrees to the northward, and then south-easterly to Cherry Island; — which having passed, it assumes a direct course a little south of east, until it forms a junction with the Siberian or Nova Zemblan coast.

That remarkable promontory, formed by the sudden stretch of the ice to the north, constitutes the line of separation between the east or whale-fishing, and west or *sealing* ice of the fishers; And the deep bay lying to the east of this point, invariably forms the only pervious track for proceeding to fishing latitudes northward. When the ice at the extremity of this bay occurs so strong and compact as to prevent the approach to the shores of Spitzbergen, and the advance northward beyond

* Latitude 71 N.; longitude about 5½° W.

the latitudes of 75° or 76°, it is said to be a *close season*; and, on the contrary, it is called an *open season*, when an uninterrupted navigation extends along the western coast of Spitzbergen to Hackluyt's Headland. In an open season, therefore, a large channel of water lies between the land and the ice, from 20 to 50 leagues in breadth, extending to the latitude of 79° or 80°, and gradually approximating the coast, until it at length effects a coalition with the north-western extremity, by a semi-circular head. When the continuity of the mass of ice, intervening between West Greenland and Nova Zembla, is thus interrupted in an open season, the ice again makes its appearance on the south of Spitzbergen, proceeding from thence direct to Cherry Island, and then eastward as before.

Such is the general appearance of the margin or outline of the polar ice, which holds, with merely partial changes, for many successive seasons. This outline, however, is necessarily more or less affected by storms and currents: their more than ordinary prevalence in any one direction, must cause some variety of aspect in particular places, which becomes more especially apparent in the vicinity of land, where its coasts afford marks by which to estimate the advance and retreat of the ice.

The line formed by the exterior of the ice, is variously indented, and very rarely appears direct or uniform. Open bays or arms occur, from a few fathoms, to several miles in length. None of them, however have any determinate form or place, except the "*Whale-fisher's Bight,*" or great bay before described, in which the Greenlandmen ever seek a passage to the fishing stations.

The place where whales occur in the greatest abundance, is generally found to be in the 78th or 79th degree of north latitude, though from the 72d to the 81st degree they have been met with. They seem to prefer those situations which afford them the most secure retreats. Among the ice, they have an occasional shelter; but so far as it is permeable, the security is rather apparent than real. That they are conscious of its affording them shelter, we can readily perceive, from observing that the course of their flight when scared or

wounded, is generally towards the nearest or most compact ice. At one time, their favourite haunt is amidst the huge and extended masses of the field ice; at another, in the open seas adjacent. Sometimes the majority of the whales inhabiting those seas, seem collected within a small and single circuit; at others, they are scattered in various hordes, and numerous single individuals, over an amazing extent of surface. To discover and reach the haunts of the whale, is an object of the first consideration in the fishery, and occasionally the most difficult and laborious to accomplish. In *close seasons,* though the ice joins the south of Spitzbergen, and thereby forms a barrier against the fishing-stations, yet this barrier is often of a limited extent, and terminates on the coasts of Spitzbergen in an open space, either forming, or leading to, the retreat of the whales. Such space is sometimes frozen over until the middle or end of the month of May, but not unfrequently free of ice. The *barrier* here opposed to the fisher, usually consists of a mass of ice from 20 to 30 or 40 leagues across in the shortest diameter It is generally composed of packed ice, and often cemented into a continuous *field* by the interference of *bay* ice, which incredibly augments the difficulty of navigating among it.

As the time that can be devoted to the whale-fishery, is, by the nature of the climate, limited to three or four months in the year, it is of importance to pass this *barrier* of ice as early as possible in the season. The fisher here avails himself of every power within his command. The sails are expanded in favourable winds, and withdrawn in contrary breezes. The ship is urged forward amongst the *drift* ice through the force of the wind, assisted by ropes and saws. Whenever a *vein of water,* as it is called, appears in the required direction, it is if possible attained. It always affords a temporary relief, and sometimes a permanent release, by extending itself through intricate mazes, amidst ice of various descriptions, until at length it opens into the desired place, void of obstruction, and the retreat of the whales.

The formidable barrier before described, is regularly encountered on the first arrival of Greenland ships in the month

of April, but is generally removed by natural means as the season advances. However extensive, huge, and compact it may be, it is usually found separated from the land, and divided asunder by the close of the month of June; and hence it is, that however difficult and laborious may have been the ingress into the fishing country, the egress is commonly effected without particular inconvenience.

That the ice should envelope the whole coasts of Spitzbergen in the winter season, and expose the western shore about the month of June; that the ocean should be almost annually navigable on the meridians of 5° to 10° E., to the 80th degree of north latitude, whilst the ice in every other part of the world, can rarely be penetrated beyond the 74th degree, are facts highly curious, and certainly worthy of consideration.

On the recession of the ice from the west side of the land, a lane of water must be left from one extremity to the other; while to the south of Point Look-Out, a parallel motion of the ice, leaves no opening or evidence of its change of place; for here, the ice meeting with no obstruction to cause it to divide, moves on in a solid body, retained firm and unbroken by the tenacious *solder* of the interjacent *bay* ice.

In the month of May, the severity of the frost relaxes, and the temperature occasionally approaches within a few degrees of the freezing point: the brine then exerts its liquefying energy, and destroys the tenacity of the bay ice, makes inroads in its parts by enlarging its pores into holes, diminishes its thickness, and, in the language of the whale-fisher, completely *rots* it. The packed drift ice is then loosed; it submits to the laws of detached floating bodies, and obeys the slightest impulses of the winds or currents. The heavier having more stability than the lighter, an apparent difference of movement obtains among the pieces. Holes and lanes of water are formed, which allow the entrance and progress of the ships, without that stubborn resistance offered earlier in the spring of the year.

Bay ice is sometimes serviceable to the whalefishers, in preserving them from the brunt of the heavy ice, by embedding

their ships, and occasioning an equable pressure on every part of the vessel: but, in other respects, it is the greatest pest they meet with in all their labours: it is troublesome in the fishery, and in the progress to the fishing ground; it is often the means of *besetment*, as it is called, and thence the primary cause of every other calamity. Heavy ice, many feet in thickness, and in detached pieces of from 50 to 100 tons weight each, though crowded together in the form of a pack, may be penetrated, in a favourable gale, with tolerable dispatch; whilst a sheet of bay ice, of a few inches only in thickness, with the same advantage of wind, will often arrest the progress of the ship, and render her in a few minutes immoveable. If this ice be too strong to be broken by the weight of a boat, recourse must be had to sawing, an operation slow and laborious in the extreme.

When the warmth of the season has rotted the bay ice, the passage to the northward can generally be accomplished with a very great saving of labour. Therefore it was, the older fishers seldom or never used to attempt it before the 10th of May, and foreigners are in general late. Sometimes late arrivals are otherwise beneficial; since it frequently happens, in *close seasons*, that ships entering the ice about the middle of May, obtain an advantage over those preceding them, by gaining a situation more eligible, on account of its nearness to the land. Their predecessors, meanwhile, are drifted off to the westward with the ice, and cannot recover their easting; for, they are encompassed with a large quantity of ice, and have a greater distance to go than when they first entered, and on a course precisely in opposition to the direction of the most prevailing winds. Hence it appears, that it would be economical and beneficial to sail so late, as not to reach the *country* before the middle of May, or to persevere on the seal catching stations until that time. There are, however, some weighty objections to this method. *Open seasons* occasionally occur, and great progress may sometimes be made in the fishery before that time.

The change which takes place in the ice amidst which the whale-fisher pursues his object, is, towards the close of the

season, indeed astonishing. For, not only does it separate into its original individual portions, not only does it retreat in a body from the western coast of Spitzbergen, but in general, that whole barrier of ice which encloses the fishing site in the spring, which costs the fisher immense labour and anxiety to penetrate, after retarding his advance towards the north, and progress in the fishery, for the space of several weeks,—spontaneously divides in the midst about the month of June, and on the return of the ships is not at all to be seen! Then is the sea rendered freely navigable from the very haunts of the whales, to the expanse of the Northern and Atlantic Oceans.

On the Properties, peculiar Movements, and Drifting of the Ice. —1. The ice always has a tendency to separate during calms. This property holds, both with regard to field and drift ice, and seems to arise from a repelling tendency between the individual masses. Hence it is, that when the heavy ice is released from its confinement by the dissolution of the intruding bay ice, a calm generally spreads its pieces abroad, and allows a free passage for ships, which before could not be urged forward with all the assistance to be derived from the wind combined with every effort of art. From the same cause, it is, that ice, which with strong winds, is formed into compact *streams* or *patches,* and allows a safe and commodious passage amidst these large aggregations,—on the occurrence of one or two days of calm weather, will be disseminated into every opening, and seem to fill every space, allowing only a troublesome and sinuous navigation. In this case, the dispersion is so general, that scarcely any two pieces can be said to touch each other.

Openings in *packs,* and amidst fields, frequently break out or disappear without any apparent cause. It is often of importance to the fisher to determine, whether any space be in the course of diminishing or enlarging. The freezing of the water generally affords an intimation of its coarcting, as it rarely occurs on the extension of the bounding ice. The birds likewise instinctively leave the closing spaces, and fly in search of such as are in the course of opening.

2. The amazing changes which take place in the most

compact ice, are often unaccountable. They astonish even those who are accustomed to their occurrence. Thus, ships immoveably fixed with regard to the ice, have been known to perform a complete revolution in a few hours; and two ships *beset* a few furlongs apart, within the most compact pack, have sometimes been separated to the distance of several leagues within the space of two or three days, notwithstanding the apparent continuity of the pack remained unbroken!

3. When speaking of the formation of fields, it has been remarked, that the polar ice has a constant tendency to drift to the south-westward; with regard to which, it may be observed, that in situations near the western coast of Spitzbergen, this tendency is seldom observed, but rather the contrary. This may probably result from the effects of the tide, eddies, or peculiar pressures. Its universal prevalence, however, at a distance from the land, though with some slight variations, may be illustrated, observes Mr. S. by numerous facts of almost annual occurrence.

Effects of the Ice on the Sea and the Atmosphere.—The profusion of ice in the polar regions, produces peculiar and marked effects on the surrounding elements. The sea, in consequence, exhibits some interesting characters, and the atmosphere, some striking phenomena. Of these, the power the ice exerts on the wind,—on aqueous vapour,—on the colour of the sky,—and on the temperature of the air, are the most prominent; and of those, accordingly as the ice or swell has the ascendancy, the results are varied and remarkable.

1. When the wind blows forcibly across a solid pack or field of ice, its power is much diminished ere it traverses many miles: insomuch, that a storm will frequently blow for several hours on one side of a field, before it be perceptible on the other; and, while a storm prevails in open water, ships beset within sight, will not experience one-half of its severity.

It is not uncommon for the ice to produce the effect of repulsing and balancing an assailing wind. Thus, when a

severe storm blows from the sea, directly towards the main body of ice, an opposite current will sometimes prevail on the borders of the ice; and such conflicting winds have been observed to counterpoise each other, a few furlongs distant from the ice, for several hours: the violence of the one, being, as it were, subdued by the frigorific repulsion and lesser force of the other. The effect resulting, is singular and manifest.

2. The moist and temperate gale from the southward, becomes chilled on commixture with the northern breeze, and discharges its surplus humidity in the thickest snow. As the quantity of the snow depends considerably on the difference of temperature of the two assimilating streams of air, it follows, that the largest proportion must be precipitated on the exterior of the main body of ice, where the contrast of temperature is the greatest: and since that contrast must be gradually diminished, as the air passes over the gelid surface of the ice, much of its superabundant moisture must generally be discharged before it reaches the interior. Hence, we can account for the fewness of the clouds,—the consequent brightness of the atmosphere,—and the rareness of storms, in situations far immured among the northern ice. From this consideration, it might be supposed, that after the precipitation of a certain small depth of snow on the interior ice, the atmosphere could alone replenish its moisture from the same surface, and that whatever changes of temperature might occur, it could only discharge the same again: or, in other words, that the very same moisture would be alternately evaporated and deposited, without a possibility of adding to a limited depth of snow. Now, this would assuredly be the case, if nothing more than the same moisture evaporated from the snowy surface of ice, were again deposited. But, it must be observed, that notwithstanding winds from the north, east, or west, may not furnish any considerable quantity of snow; and that although those warm and humid storms which blow from the south, may afford a large proportion of their humidity to the *exterior* ice; yet, as the temperature of the northern regions would be gradually elevated, by the long

continuance of a southerly gale, the advance of the wind must in consequence be farther and farther before it be reduced to the temperature of the ice; and, therefore, some snow would continue to be precipitated to an increasing and unlimited extent.

Hence, as winds blowing from the north must be replaced by air neither colder nor less damp, and as every commixture with warmer streams, must produce an increased capacity for moisture; therefore, no wind can occasion a detraction of vapour from the circumpolar regions: on the contrary, as the snow deposited on the interior ice by southerly storms, (from the nature of the circumstances), must be derived from evaporations out of the sea; it is evident, that there must be an increase of snow in the icy latitudes, and that we cannot possibly determine any limit beyond which it may be affirmed that no snow can be deposited.

3. On approaching a pack, field, or other compact aggregation of ice, the phenomenon of the *ice-blink* is seen whenever the horizon is tolerably free from clouds, and in some cases even under a thick sky. The *ice-blink* consists in a stratum of a lucid whiteness, which appears in that part of the atmosphere next the horizon. It is evidently occasioned thus: those rays of light which strike on the snowy surface of the ice, are reflected into the superincumbent air, where they become visible; but the light which falls on the sea is in a great measure absorbed, and the superincumbent air retains its native ethereal hue. Hence, when the ice-blink occurs under the most favourable circumstances, it affords to the eye a beautiful and perfect map of the ice, twenty or thirty miles beyond the limit of direct vision, but less distinct in proportion as the air is hazy. The ice-blink not only shews the figure of the ice, but enables the experienced observer to judge, whether the ice thus pictured be field or packed ice; if the latter, whether it be compact or open, bay or heavy ice. Field ice affords the most lucid *blink*, accompanied with a tinge of yellow; that of packs is more purely white; and of bay-ice, greyish. The land, on account of its snowy covering, likewise

occasions a blink, which is yellowish, and not much unlike that produced by the ice of fields.

4. The ice operates as a powerful equaliser of temperature. In the 80th degree of north latitude, at the edge of the main body of ice, with a northerly gale of wind, the cold is not sensibly greater than in the 70th degree, under similar circumstances.

5. The reciprocal action of the ice and the sea on each other, is particularly striking, whichever may have the ascendancy. If, on the one hand, the ice be arranged with a certain form of aggregation, and in due solidity, it becomes capable of resisting the turbulence of the ocean, and can, with but little comparative diminution or breaking, suppress its most violent surges. Its resistance is so effectual, that ships sheltered by it, rarely find the sea disturbed by swells. On the other hand, the most formidable fields yield to the slightest *grown* swell, and become disrupted into thousands of pieces; and ice of only a few weeks growth, on being assailed by a turbulent sea, is broken and annihilated with incredible celerity. Ice, which for weeks has been an increasing pest to the whale-fisher, is sometimes removed in the space of a few hours. The destruction is in many cases so rapid, that to an inexperienced observer, the occurrence seems incredible, and rather an illusion of fancy, than a matter of fact. Suppose a ship immoveably fixed in bay ice, and not the smallest opening to be seen: after a lapse of time sufficient only for a moderate repose, imagine a person rising from his bed,—when, behold, the insurmountable obstacle has vanished! Instead of a sheet of ice expanding unbroken to the verge of the horizon on every side, an undulating sea relieves the prospect, wherein floats, the wreck of the ice, reduced apparently to a small fraction of its original bulk.

That ice should be forming or increasing when exposed to the swells of the ocean, while the annihilation of bay ice is so sudden and complete, might seem an anomaly or impossibility, were the circumstances passed over in silence. It must be observed, that the operation of a swell is merely to rend the

bay ice in pieces, while its destruction is principally effected, by the attrition of those pieces against each other, and the washing of the *wind-lipper.** Herein the essential difference consists: *pancake* ice is formed in masses so small and so strong, that the swell will not divide them; and the effect of the *wind-lipper* is repressed by the formation of *sludge* on its seaward margin. Hence, whenever ice does occur in agitated waters, its exterior is always *sludge*, and its interior pancake ice, the pieces of which gradually increase in size with the distance from the edge.

When a swell occurs in crowded, yet detached ice, accompanied with thick weather and storm, it presents one of the most dangerous and terrific navigations that can be conceived, each lump of ice, by its laborious motion, and its violent concussion of the water, becomes buried in foam, which, with its rapid drift, and the attendant horrid noise, inspires the passing mariner with the most alarming impressions; whilst the scene before him is, if possible, rendered more awful by his consciousness of the many disasters which have been occasioned by similar dangers.

Mr. Scoresby's paper concludes with some remarks on the *possibility of travelling to the North Pole,* together with a sketch of the reasoning on which the probability of success depends.

We are for the present unable to lay any part of them before our readers, but we should remark, that in 1806, the ship Resolution, commanded by Mr. Scoresby's father, and in which Mr. Scoresby served as chief mate, was forced, by astonishing efforts, through a vast body of ice, which commenced in the place of the usual *barrier*, but exceeded its general extent by at least a hundred miles. They then reached a navigable sea, and advanced, without hinderance, to the latitude of $81\frac{1}{2}°$ north, a distance of only 170 leagues from the Pole; which it is imagined is one of the most extraordinary approximations yet realised.

* The first effects of a breeze of wind on smooth water is, by seamen, called *wind-lipper.* From it, all high seas are derived, and it is always apparent on their surfaces. Oil cast upon the sea suppresses the wind-lipper, and a similar effect is produced by the formation of ice *sludge* in the sea, from sudden extreme cold.

Mr. Scoresby has announced his intention of publishing a work comprehending *an Account of the progress of discovery in the North, with a synopsis of the numerous voyages undertaken in search of a Northern Passage to India.—An Account of West Greenland.—East Greenland, or Spitzbergen.—The natural history of the Greenland Seas.—An account of the Greenland Sea.—The Polar Ice.—The history of the northern Whale Fishery.—The history of the minor Fisheries.—A Journal of a Greenland Whale-Fishing Voyage,—With Appendix; containing a series of Meteorological Tables.—Tables of the Variation of the Compass, Latitudes and Longitudes, &c. from original observations.* There can be little question but that Mr. Scoresby's experience and information on these subjects, will qualify him for the task he has undertaken.*

Art. IX. *On the Solution of Silver in Ammonia; by M.* Faraday, *Chemical Assistant in the Royal Institution.*

The ease with which the compounds of silver are dissolved by ammonia, and the frequent formation of powerfully detonating and dangerous substances in these solutions, are well known. I have been induced to examine some of the phenomena presented by these bodies, and perhaps an account of what is (I believe) original, may not be unacceptable as an addition to the scanty stock of information published on this subject.

When the oxide of silver, precipitated either by the alkalies or alkaline earths, is put into solution of ammonia, it is entirely dissolved, producing a pale brownish solution. If this solution be exposed in an open vessel, a brilliant pellicle forms on its surface, which, when removed, is succeeded by another and another, until most of the metal is separated.

* It should be observed, that the ice in the vicinity of Spitzbergen has been progressively diminishing in quantity, on the west side at least, for the last three years.

This, which is an oxide of silver, was noticed long ago by Berthollet in the Annales de Chimie, Tome 1, and he there states its production to be dependant on the abstraction of ammonia by the atmosphere.

From some difference which exists between this solution of silver and that of the nitrate when treated by precipitants, and from other circumstances, I was induced to collect and analyze some of the oxide, to ascertain its identity with the common oxide, or that previously dissolved. 20 grains that had been dried for some hours on the sand bath, were put into a small glass retort, they were decomposed by heat, and the gas liberated received over water; it equalled 2.75 cubical inches. 18 grains of silver remained in the retort, and the 2.75 of oxygen being equivalent to ,935 grains, we have those numbers as the proportions of the elements in the oxide, the loss being supposed to be water, some of which had condensed in the neck of the retort. Now;

oxygen.	silver.	oxygen.	silver.
,935	18	7.5	144.4

The same method of analysis was applied to oxide of silver, precipitated by posash from nitrate of silver, it having been well washed and dried: 40 grains gave 7.9 cubical inches, and 36.4 grains of silver remained. The 7.9 cubical inches = 2.686 grains, and

oxygen.	silver.	oxygen.	silver.
2.686	36.4	7.5	101.6

the number for silver very nearly as given in the most correct elementary treatises on chemistry. There appears, therefore, to be no error in the mode of analysis, and the oxide by ammonia seems to contain less oxygen than that precipitated by alkalis. Again,

30 grains of the oxide of silver were put into a retort, and decomposed with every precaution as before; the silver left weighed 27.4 grains, and the quantity of gas given off was 4.125 cubical inches. I suspected that a small portion of carbonate of silver had been mixed with the oxide, for when the ammoniacal solution has been long exposed to the air, much carbonate of ammonia and of silver is formed in it. the gases were therefore placed over solution of potash, and

were reduced in bulk to 3.625, which was pure oxygen. This volume is equivalent to 1.2325 grs., and 1,2325 : 27,4 : : 7.5 : 166.7, a proportion of silver still higher than in the first experiment, but which may be accounted for by the purification of gas and the small quantity of oxygen that remained in the retort.

In a third experiment, 24 grains of silver were left; 4.25 cubical inches of gas were given off, which decreased over potash to 4. In order to estimate the proportion of azote arising from the air in the retort, the 4 were treated with nitrous gas of known purity, and gave results equal to 3.475 of pure oxygen. This is equal to 1,1815 grs. and 1.1815 : 24 : : 7.5 : 152.3.

One or two other experiments varied considerably from this, giving a greater proportion of silver, but the mean of many gave the oxygen to the silver as 7.5 to 157.4.

There is every reason, therefore, to believe this a protoxide of silver, containing about two thirds the quantity of oxygen found in the common oxide, or that obtained by precipitation from the nitrate; and there are also other circumstances observable in its solution and during its formation which favour this notion.

When this oxide forms on the surface of an ammoniacal solution by slow spontaneous evaporation, it takes a crystalline form, which, however, is quickly lost by its covering the whole surface of the liquor. It is of a gray colour by reflected light, and highly resplendent; by light transmitted through thin films, it is of a bright yellow colour. When heated gradually it is reduced, giving off oxygen without change of form; but heated suddenly, it fuses first, and leaves a solid button of silver: under pressure, it perhaps might be fused without decomposition.

Potash precipitates the solution of oxide of silver in ammonia white; carbonate, or subcarbonate more abundantly, and white; alcohol and ether throw down precipitates, at first white, but rapidly changing colour; when dry, they detonate by heat or friction. Chromate of ammonia does not precipitate until nitric acid be added Tincture of galls gives a very copious black precipitate, different in appearance to that obtained from the nitrate of silver by adding ammonia

after the tincture. Solution of iode in water gives a brown curdy precipitate, but with nitrate of silver a yellow turbidness. Muriatic acid or muriate always forms chloride of silver.

It is probable, from these circumstances, that part of the silver exists in the solution in the state of protoxide, and as no gas is given off during the solution of the original oxide, that a portion of nitric acid and water have been formed.

M. Berthollet has in the paper before referred to, described a fulminating compound of silver and ammonia, obtained from solutions similar to those from which the above oxide had been obtained, and has stated it to be his opinion that it is a compound of protoxide of silver and ammonia. As it is frequently left in the form of a black powder when oxide of silver is dissolved in ammonia, I imagined it might be a compound of the per-oxide with the alkali, as protoxide was formed and held in solution; and that the circumstance of the liberation of azote, which gave rise to the idea of its being a combined protoxide, might be explained by the further formation of a portion of oxide similar to that already described.

The method of obtaining this compound has been to precipitate oxide of silver from the nitrate by alkalies, or better lime water, to wash and dry it well. and then to leave it in contact with liquid ammonia for ten or twelve hours; the greater part is dissolved, but a black powder remains, which is fulminating silver; if the solution be heated, azote is given off, and a further quantity of fulminating silver is obtained Annales de Chimie, Tome 1.

I find that fulminating silver may be formed from any precipitated oxide of silver, whether moist or dry, recent or old. Boil the oxide carefully in a tube with a mixed solution of potash and ammonia for a few moments, the potash absorbs all the carbonic acid that may have been united to the oxide, and to a certain degree prevents its solution in the ammonia; a black powder, similar to that procured by the other process results.

In order to gain some evidence respecting the nature of

the oxide combined with the ammonia, in fulminating silver, I endeavoured to ascertain the mode of formation of that compound. It appears to be formed in every case where common oxide of silver is dissolved in ammonia, and the entire solution of all solid matter is no evidence of its non-existence, for the compound is itself soluble in ammonia, though not so much so as the oxide. When there is an excess of oxide, unless it predominate in a great degree, the undissolved portion will be found to contain fulminating silver, and when the whole is dissolved, by heating the solution, it is thrown down.

To ascertain whether the liberation of azote depended upon the formation of the fulminating compound, I boiled, for a few moments, a solution of the oxide in ammonia; the solution became highly coloured, azote was given off, and a black curdy precipitate formed, which left the liquid colourless; separated by a filtre, the precipitate proved to be fulminating silver. The solution was again heated, it again blackened, gave off azote, and again a precipitate formed; this was not fulminating silver, but merely oxide: filtered and again heated, it gave off azote, and more of the oxide was formed; and this occurred with the same solution a fourth and fifth time. The liberation of the azote, therefore, does not belong exclusively to the formation of fulminating silver, but seems rather to depend on the production of protoxide.

I endeavoured to form fulminating silver by using the protoxide described in the first part of this paper, but could not succeed; I got nothing but a black powder from it, which appeared to be the same oxide in another form. I endeavoured also to form fulminating silver from those portions of oxide given off by the further boiling of solutions which had previously yielded the detonating compound, but failed; I presume from its being also a protoxide. When the fulminating compound is dissolved in the acids, it gives off a gas which I believe to be oxygen, but I could not work with quantities sufficient to ascertain this point. Perhaps to these reasons for supposing fulminating silver to be a compound rather of the preoxide than the protoxide, may be added the easy

solubility of the protoxide in ammonia, and the difficult solubility of the detonating compound.

The oxide, which is obtained by boiling solution of silver in ammonia, I have supposed to be a protoxide similar to the one obtained by spontaneous evaporation. This opinion is founded on the liberation of azote during its formation in consequence of the decomposition of ammonia by oxygen, and on its apparent incapability of forming fulminating compounds, the idea is supported by the following circumstance. A tube, in which solutions of silver in ammonia had been repeatedly boiled, became coated on the inside with the oxide, so as to be perfectly opaque; on pouring dilute nitric acid into it to remove the oxide the tube became lined with brilliant metallic silver, which, however, was soon dissolved by the continued action of the acid. I attribute this phenomenon to the reduction of one part of the oxide by another, which was thus rendered soluble in the acid.

When a portion of the ammoniacal solution is evaporated to dryness in a platinum capsule, it leaves a film of oxide, which, when decomposed by heat, gives a perfectly continuous and smooth coat of silver to the vessel. I have also covered other metals, as iron and copper, with silver, in the same way, and found that the burnisher might be applied without any injury to the coating. It is probable that a solution of silver of this kind might be applied in some cases in the arts, to the purposes of ornament and utility.

Art. X. *A Comparative Analysis of the Green and Blue Carbonates of Copper.* By Richard Phillips, *Esq. F. L. S. and M. Geol. Soc.*

I some time since commenced an analysis of the carbonates of copper, under the impression that the blue carbonate or azure copper ore, had not been examined since Pelletier published his analysis of it, in the 13th vol. of the Annales de Chimie.

Since I have completed the investigation I have found by reference to Mr. Allan's very useful work, intitled "Minera-

logical Nomenclature," &c. that both Klaproth and Vauquelin have analysed not only the green carbonate, but the blue also; I was indeed aware that green carbonate had been examined by the former chemist: this being the case, it may appear presumptuous in me to offer the result of my investigation; and I should probably have withheld it, but that some collateral facts have transpired, which appear to me not altogether devoid of interest, and as far as I know, they have not before been noticed.

According to the celebrated chemists above named, the green carbonate of copper is constituted as follows:

	Klaproth.	Vauquelin.
Copper - -	58	56.1
Oxygen - -	12.5	14.
Carbonic acid -	18.	21.25
Water - -	11.5	8.65
	100.0	100.00

I shall now relate the experiments which I have made upon this carbonate.

Two hundred grains of green carbonate of copper heated to redness in a platina crucible, became perfectly black, and lost 55,6 grains.

I put some nitric acid into a small vial, the stopper of which had been perforated, and a glass tube passed through it, to suffer the escape of the carbonic acid gas; the weight of the vial and acid being taken, I gradually put into it 200 grains of green carbonate of copper in small fragments. When the solution was complete, I found that 37 grains of carbonic acid had been evolved. If then from 200 we subtract 55.6, the loss by heat, we have 144.4 as the quantity of peroxyd of copper, and if from 55.6 we take 37, the carbonic acid, there remain 18.6 as the proportion of water dissipated by heat. One hundred parts of green carbonate of copper consist of

Peroxyd of copper -	72.2
Carbonic acid - -	18.5
Water - - -	9.3
	100.0

On examining the solution I found it to be pure nitrate copper.

It will be observed that the abovementioned proportions agree much more nearly with the analysis of Vauquelin than that of Klaproth; and yet I am induced, from considering the numbers representing oxyd of copper, carbonic acid, and water on Dr. Wollaston's scale, to suppose that neither of these analyses is perfectly correct.

The number for peroxyd of copper on the scale is 50; but it appears to me that Dr. Thomson is more correct in fixing it at 100, oxygen being at 10, or at 75, oxygen being 7.5; with this alteration the number representing peroxyd of copper will be 75, carbonic acid 20.65, and water 8.5.

If then we consider green carbonate of copper as constituted of one atom, proportion, or particle of oxyd, acid and water, 100 parts will consist of nearly

Peroxyd of copper -	72.01
Carbonic acid - -	19.82
Water - -	8.17
	100.00

These proportions differ very little from those stated by Vauquelin, or from the analysis which I have given; whilst the quantity of oxyd of copper is considerably less than that in Klaproth's results, and it appears that the difference arises from an erroneous estimate of the composition of peroxyd of copper.

It is universally admitted that peroxyd of copper, which is that contained in the carbonates, and other cupreous salts, is composed of exactly 4 parts of copper and one part of oxygen, whereas in the analysis to which I now allude, the oxygen is to the copper only as 12.5 instead of 14.5 to 58.

I shall now quote from Mr. Allan the analysis of the blue carbonate of copper, by the chemists already named.

	Klaproth.	Vauquelin.
Copper - -	56. -	56.
Oxygen - -	14. -	12.5
Carbonic acid -	24. -	25.
Water -	6. -	6.5
	100.	100.0

In comparing these statements it will be seen that Klaproth has assigned the proper quantity of oxygen to the copper, whilst Vauquelin has under-rated it exactly as much in this analysis as Klaproth in the former.

The experiments which I made upon the blue carbonate, I shall now describe.

Two hundred grains subjected to a red heat, became black, and lost 60 grains, which were of course carbonic acid and water.

To ascertain the proportion of carbonic acid, I employed the vial already described: 200 grains of the ore, gave out 49.4 of carbonic acid, by the action of nitric acid.

The specimen of carbonate which I employed was slightly intermixed with peroxyd of iron, and I found that 6 grains of it remained insoluble in the nitric acid; but the solution was pure nitrate of copper.

If from 200 we take 6, there remain 194 as the pure carbonate employed; if from this quantity we subtract 60, the loss by heat, we have 134 of peroxyd; and if from 60 we deduct 49.4, the carbonic acid, the remainder 10.6 will denote the quantity of water.

One hundred parts of the blue carbonate of copper according to this statement consist of, nearly

Peroxyd of copper - -	69,08
Carbonic acid - -	25.46
Water - -	5.46
	100.00

These quantities of oxyd and water, agree very nearly with Klaproth's determination, and the carbonic acid with Vauquelin's result.

I have already observed that the green carbonate may be considered as constituted of an atom of each of its binary constituents, the oxyd, acid, and water, and on comparing the analysis of the two carbonates it will be found, that the blue, consists of peroxyd of copper, combined with one third more carbonic acid, and one third less water than the green; it may therefore be regarded as composed of

		By theory.	By exper.
3 atoms of peroxyd of copper	= 75. × 3	= 225.	= 225.
4 atoms of carbonic acid	= 20.65 × 4	= 82.6	= 82.9
2 atoms of water - -	= 8.5 × 2	= 17.	= 17.8

The green and blue are I believe the only carbonates of copper commonly known to mineralogists; Dr. Thomson (Chemistry, Vol. III. 464) gives the analysis of a carbonate of copper which is remarkable for containing no water. It consists of 16.7 carbonic acid, combined with 60.75 peroxyd of copper, so that the oxyd of copper is not a hydrate; and it appears to be owing to this circumstance that its colour, instead of being green or blue, is blackish brown.

To recapitulate: we may then consider the three native carbonates at present known as thus constituted:

	Peroxyd of copper.	Carb. acid.	Water.
Green carbonate,	1 atom.	1 atom.	1 atom.
Blue ditto, -	3 atoms.	4 atoms.	2 atoms.
Anhydrous ditto,	1 atom.	1 atom.	

Having concluded my experiments and observations on the natural carbonates of copper, I proceeded to determine whether the artificial products resemble them, or if they should be found to differ, to examine in what the difference consists.

The first substance which excited my attention is the pigment known in the arts by the name of blue verditer: this is prepared by silver refiners, from the solution of nitrate of copper remaining after precipitating the silver from nitric acid; the best is called refiner's verditer, to distinguish it from an inferior and different compound, obtained from the decomposition of sulphate of copper by lime.

Blue verditer has been already analysed by Pelletier, and his examination, which is the only one that I have seen, is printed in the 13th vol. of the Annales de Chimie; and the composition of what he states and supposed to be the best English verditer, is as follows:

Copper - -	50.
Oxygen - -	$9.\frac{2}{3}$
Carbonic acid - -	30.
Lime - -	7.
Water - - -	$3.\frac{1}{3}$
	100.

One circumstance is of itself sufficient to prove that this analysis is erroneous, viz. the quantity of oxygen is not equal to one fourth of the weight of the copper, it being only 9.66 instead of 12.5; and it will be found as we proceed that, if the other parts of the analysis approach even to correctness, that Pelletier must have been deceived as to the quality of the verditer he employed.

The first experiment which I shall state with regard to this substance, is that performed to ascertain whether it contains any sub-nitrate of copper. With this intention I boiled a quantity of it in lime water; it became almost immediately black; I concluded, therefore, that if it contained any nitric acid, that it had combined with the lime, and been converted into nitrate.

I filtered the solution, and on adding carbonate of ammonia, I could not obtain any precipitate; it was evident therefore that no nitrate of lime had been formed.

It may be objected to this experiment that the lime, instead of combining with the nitric acid of the sub-nitrate, had been converted into carbonate, by the carbonic acid of the carbonate of copper; to try whether this had been the case, I added some sub-nitrate of copper to the verditer, and boiled the mixture in lime water; the clear solution did not affect turmeric paper, but it immediately gave a copious precipitate with carbonate of ammonia; showing that sub-nitrate of copper is more readily decomposed by lime water than carbonate of copper is, and consequently, that verditer is free from the sub-nitrate.

I next dried 200 grains of verditer by exposure to nearly the greatest heat it could sustain, without injuring its fine colour, an effect which is readily produced, and by which it is first rendered green, and eventually black. I found that the 200 grains lost 2.3 gr. in weight; and farther to ascertain whether it contained any impurity either soluble or insoluble, I added 200 grains of it to nitric acid, which left 2.4 grs. of earthy matter unacted upon.

To the filtered nitrate I added ammonia, which at first precipitated and afterwards redissolved every substance that the

nitric acid had taken up. To the clear ammoniacal solution I put carbonate of ammonia, without its producing the slightest effect. The verditer, therefore, contains no lime, nor any soluble impurity whatever; and we may consider it as mixed with 4.7 of adventitious matter in 200 grs. I proceeded next to ascertain the aggregate weight of the carbonic acid and water dissipated, by subjecting 200 grains of verditer to a red heat; I found, when it had become quite black, that the loss amounted to 62 grains.

As nitric acid acts with great rapidity upon this substance, on account of its state of minute division, it was requisite, in determining the quantity of carbonic acid, to employ a much larger vial than in the former experiments; to the carbonic acid therefore actually evolved, I added the difference between the weight of atmospheric air contained in the vial, and that of the carbonic acid which had displaced it.

In this way 200 grains of verditer lost 48.2 grains of carbonic acid. If from 200 we substract 4.7 for adventitious matter, we shall have 195.3 of pure verditer, losing 60 by heat, and 48.2 by nitric acid; and by substracting 48.2 from 60, there remain 11.8 as the quantity of combined water.

One hundred parts consist nearly of

Peroxyd of copper -	67.6
Carbonic acid - -	24.1
Water - -	5.9
Impurity and moisture -	2.4
	100.0

Viewing its composition as atomic, it is constituted of

		By theory.	By exper.
3 atoms of peroxyd of copper	75. × 3 =	225. =	225.
4 atoms of carbonic acid	20,65 × 4 =	82.6 =	80.
2 atoms of water - -	8.5 × 2 =	17. =	19.6

It appears, then, that making some allowance for the imperfection of the analysis, that blue verditer perfectly resembles the blue carbonate of copper in the nature and proportions of its constituents; and if the latter be finely

powdered, it is scarcely possible to distinguish any difference of colour on comparing them.

According to Proust, (Ann. de Chimie, 32.) when 100 grains of copper are dissolved in nitric acid, and the solution is decomposed by an alkaline carbonate, the precipitate weighs when dried 181 grains, composed of 125 peroxide of copper, 46 carbonic acid, and 10 water; and if we compare these quantities with the analysis of the natural and artificial blue carbonate, it will be found, that the precipitate obtained by Proust, is perfectly similar in its composition, and the colour is also blue, but not nearly so fine as that of verditer, and it is harsh to the touch.

The mode of preparing refiner's verditer is kept as much as possible a secret; and although I have some reason for believing that carbonate of lime is employed in the process, yet I am quite at a loss to imagine how colour, or even carbonic acid, can be imparted to oxide of copper by its action. If to nitrate of copper in solution we add finely divided carbonate of lime, the action is very slow; much carbonic acid is however given out, and the precipitate has a green colour.

If solution of nitrate of copper be decomposed by carbonate of lime with the assistance of heat, a green precipitate is obtained, which is merely a sub-nitrate, and does not contain a particle of carbonic acid.

Pelletier, probably misled by his erroneous analysis, or by using an inferior verditer, supposed he had acquired the method of preparing it, and he advises that a solution of nitrate of copper should be decomposed by lime; and that in order to give the precipitate the requisite colour, every 100 parts of it should be rubbed with 8 or 10 parts of lime, and then dried.

I have already shewn, that lime forms no part of blue verditer, and if it did, no cause appears why, when hydrate of copper is precipitated by lime, it should contain so large a quantity of carbonic acid as verditer does; unless indeed, which can hardly be suspected, it acquires it by exposure to the atmosphere.

It appears, then, that the preparation of this pigment, requires a combination of powers, which it is difficult to obtain.

If a solution of nitrate of copper is decomposed by the alkaline carbonates, the precipitate contains the proper proportions of the several constituents, but it is totally deficient in colour and softness; if lime is used, the colour of the precipitate, although blue, is not good, and it contains no carbonic acid; and when carbonate of lime is employed, the precipitate is a green sub-nitrate.

I shall conclude with adverting to a fact, which although not immediately connected with the subject with which I have been occupied, seems singularly to have escaped observation, I mean the existence of a fulminating copper, which is thus noticed in Lewis's translation of Neumann's chemistry, 4to. p. 63, note a). "The blue mixture of solution of copper in aquafortis with volatile spirits, yields sapphire coloured crystals, which dissolve in spirit of wine, and impart their colour to it. If, instead of crystallization, the liquor be totally evaporated, the remaining dry matter explodes in a moderate heat, like aurum fulminans." I have not repeated this experiment, and therefore am ignorant how far the statement is correct.

Art. XI. *Some Remarks on the Deterioration of the Climate of Britain, with an attempt to point out its Cause.*

That for several centuries past the climate of England has undergone a very material change for the worse, appears demonstrated by the most irresistible historical evidence; nor can there indeed be a doubt that the springs are now later, and the summers shorter, and that those seasons are colder and more humid than they were in the youthful days of many persons, and those not very aged, who are now alive. We learn from our old chronicles, that the grape has formerly been cultivated in England, for the manufacture of wine, but we now know that even with much care and attention it can scarcely be brought to ripen a scanty crop under walls

exposed to the sun, sheltered from cold wind, and in every respect in the most favourable aspect; and it would be folly to attempt its growth in the method of a vineyard, as a standard. Of this real luxury of more genial climes, we have so long been deprived, that we trouble ourselves little about those golden days when Bacchus smiled upon our hills. But what may be considered as coming more home to the business and bosoms of the present generation is, that Pomona is about to desert our orchards, and that on ground where the clustering vine once flourished, the apple has of late years scarcely ripened. Indeed we are informed upon good authority, that it is now sixteen years since the orchards have afforded a plentiful crop. It is really melancholy to think that at no very remote period our posterity may in all probability be in the same situation in regard to cyder, that we are now placed in in respect to wine; when the apple tree, like the vine, will only afford a penurious supply of sour fruit, and will be cultivated in forcing houses to supply the tables of the rich.

Lest, however, we should be set down among the screech-owls of mankind, whose race, we are sorry to say, shews no symptoms of extinction, and who make it their business "to lessen the little comforts, and shorten the short pleasures of our condition by painful remembrances of the past, or melancholy prognostics of the future;" we shall now beg leave to give our readers a few facts connected with this change of climate, which may perhaps throw a little light upon the subject, and tend to exhibit the cause of those effects which we have just deplored.

It is demonstrable, that in the northern parts of our hemisphere the mean annual temperature is on the decline, and on recurring to the accounts of modern travellers, it appears that in mountainous parts of Europe the accumulation of ice and snow is very sensibly increasing. This is perhaps particularly the case, and easily observable, in the vicinity of Mont Blanc; and the Glaciers which, descending from the summits of that and the adjoining peaks, invade the adjacent valley of Chamouney, are making such progress as to threaten at no very remote period, to render the heart of that district inaccessible to

the traveller. In a recent number of the "Bibliothèque des Sciences et des Arts," Professor Pictet informs us, that the Glacier des Bossons has very lately advanced fifty feet, much to the dismay of the neighbouring villagers. But if we resort to more northern climes we shall find yet more alarming evidence of the great increase of snow and ice, and of this, the history of Greenland furnishes perhaps the most remarkable facts upon record. We know that that country, which was probably first peopled by Europeans from Iceland, received its name from its verdant appearance, and that the original colony continued to prosper, and to carry on an extensive commerce with Norway, until the beginning of the 15th century, since which period all communication with East Greenland has ceased, and what was once known respecting it is almost buried in oblivion. Since that period too, the east coast of Greenland, which once was perfectly accessible, has become blockaded by an immense collection of ice, so that till within these few months no vessels could approach near enough even to see land in that direction.

The following quotation from Fabricius* will, we presume, furnish satisfactory proof of the great increase of the inland ice of Greenland, and seems particulary apposite to our present purpose.

"The land-ice (Fisbræc) in Greenland is one of the most remarkable phenomena in nature, and in extent far exceeds any other hitherto known, running from one end of the country to the other, and covering it with an eternal ice, leaving only some tops of mountains, which rise black and naked above it. When you ascend any of the highest mountains free from ice on the sea-coast a dreadful view is presented. As far as the eye can reach in every direction nothing is seen but a glittering surface, which merits the appellation of an icy ocean.

"This ice is extending every year, increasing in height as well as breadth, and has already occupied the greatest part of the country. When it meets with high mountains it is checked in its progress till it has reached an equal height, and then proceeds farther without obstruction. An experiment has

* Nye Samling af det Kongelige Danske Videnskabers Selskabs Skrivter. T. iii. 1788.

been made of placing a pole in the earth at a considerable distance from the line of ice, and that place has been found occupied by the ice the following year. Its progress is indeed so rapid that Greenlanders, who are still living, remember their fathers hunting rein-deer among naked mountains, which are now completely covered with ice. I have myself seen foot-paths leading to the inland of this part of the country, which are now obstructed by glaciers. It is chiefly in the valleys that the ice is accumulating, and where these reach the sea, and the inner parts of the bays, the ice projects in large blocks over the water. Part of the ice appears to be even and smooth, particularly in the middle, but a part of it very uneven, especially at the extremities towards the naked land, and in those places, where small hillocks have been covered. But if you proceed farther on the ice, that which seemed to be even, consists of vallies with several strata. There are also a number of rents of different widths, and so deep that the eye seeks the bottom in vain. That part of the ice which appeared to be uneven is nothing but projecting hillocks with deep ravines, where it is impossible to proceed, and which bear the appearance of the sea in most violent motion, instantly congealed. If you look down into the rents or observe the ice at the extremities, you find the lower stratum of a blue colour, which is darker towards the bottom, but towards the surface the colour is lighter, the uppermost stratum having its natural whiteness. The noise of water-falls is heard in some of the rents, and a thundering sound is frequently heard under your feet, when a new rent is made. On inspecting the extremity of the ice, when it is forming in low places, you will find it undermining the ground and pushing it aside as if it were by a plough. This detritus lies collected in heaps all along the sides of the ice, like walls, and at the first breaking up of the ice is sunk into it for ever. In many places entire lakes are filled and rivers stopped up; the ice spares nothing.

"The blocks of ice, that form a continuation of the land-ice and project over the water in the inner parts of the bays, are yearly increasing. The sea below throws its waves over them, and makes such excavations, that in many places large poles of ice are hanging down at the sides, having the appearance

of pipes of organs, and in other places it forms immense arches. In proportion, as these blocks increase above and become heavier, and the excavations below are extended, immense masses are precipitated into the water. Many bays are really deep enough to receive such ice mountains. As one mass falls down, that which is behind is carried along with it, and thus one follows the other with a tremendous cracking noise, like a heavy cannonade. The sea, as is easily imagined, is thereby put into a violent motion, and overflows the land to a great height, and this inundation is felt at the distance of several miles. It has even happened that tents pitched at a considerable distance from the sea have been carried away and the people have perished. Boats are also in great danger.

"Such masses of ice are at first precipitated deep in the water, and returning to the surface continue for a long time in motion. Sometimes they are united to the flat ice in the bays by congelation, and thus remain surrounded by it for a time, or they break in their fall the ice which is already formed there.

"Another circumstance which increases these mountains, is that in some places there are large lakes above the ice blocks, discharging their water through openings under them. Round the edges of the lakes are hanging pieces of ice, which in the above-described manner are precipitated into them. They are then driven to the mouth of the opening, through which the smaller pieces are carried down into the sea, but the larger ones block up the opening, by which not only the water is stopped, but also the other masses of ice. The water rising higher detaches still more of those pieces, and the lake is at last so full of them, that they break a new channel. Thus the masses that were heaped one upon the other are hurled into the sea, accompanied by a continued thundering noise. The sea is put into terrible commotion, and the inhabitants in the neighbourhood, when they hear this roaring, expect to see the whole bay blocked up with ice.

"If the ice mountains remain for some time under the projecting blocks of ice (which depends on the state of the wind and the current) their size is then increased, and they rise to

a terrible height, assuming the most curious shapes. At last they are driven from one bay into another, or they advance into the sea and float about in Davis's Streight, till by moving southwards they are dissolved in more temperate latitudes. I do not mean to say that all ice mountains in Davis's Streight have their origin on Greenland, for some of them probably came from more distant regions; but I think it most probable that the greatest part of this sort of ice has been detached from the western coast, and from the eastern coast of Greenland, which they call Old Greenland."

From this and other evidence which might be adduced, it is clear that the quantity of ice in the northern regions has undergone a very considerable and even rapid increase, and we are of opinion that this circumstance is sufficient to account for that deterioration of our climate which we set out with deploring, and which, if the same causes continue to act, is equally threatening to our at present more fortunate neighbours upon the continent of Europe.*

It now becomes a question whether there are any hopes of amendment; whether matters may not take a turn the other way; and whether, by the gradual breaking up of the ice, the climate of this part of Europe may not regain its former state. In favour of this idea, it seems in the first place highly improbable, from what we know of the beneficent adjustments of Nature, that there should be no remedy or compensation provided for so great an evil; but, secondly, it seems that within the last year a very notable relaxation of the cold has actually taken place. East Greenland, as we have before mentioned, has not only been inacessible, but even invisible for a long period; but last year it was observed by one of the whalers, that the ice had there suffered a most astonishing

* From America, too, we learn, that in consequence of the coldness of the seasons, Indian corn will no longer ripen in New England, and that the farmers have consequently taken to the cultivation of wheat, which has succeeded so well, as to render it likely to supersede maize.

decrease; that about two thousand square leagues had disappeared, and that land was again visible. We learn too from Copenhagen, that intelligence was there received in August last, that the ice which from time immemorial had interrupted the communication with East Greenland had vanished. It is further probable that the process of thawing is going on to a yet greater extent further north, for the ice islands met with in the Atlantic are almost entirely conveyed thither by the southern current which constantly runs in Davis's Streight, and they were last year much more numerous than usual—many, and large ones, were even seen in 42° south latitude in the summer and autumn of 1816, and we think it by no means improbable that the extreme chillness of that season may in great measure be referred to these visitors from the north; for the south-west winds could not but have been chilled by passing over these frozen masses. We think there is one other remark worth recording, though we would not be understood to lay any stress upon its reference to, or connection with, the more propitious state of weather that we now look for—it is, that at the very time we heard of the thawing of the northern ice, and a consequent probability of the return of those regions to their former state, the westward variation of the magnetic needle began to decline, and it has already retrograded some degrees towards due north.

Art. XII. *On the Fluo-Silicic and Chloric Acids. In a Letter to the Editor from* James Lowe Wheeler, *Esq.*

Dear Sir,

While perusing the account of the Fluo-silicic acid, which is contained in the second volume of the last edition of Dr. Thomson's System of Chemistry, I observed, that this acid was said to be capable of decomposing the sulphate, nitrate, muriate, and consequently all the salts of potash.

These remarkable properties, which were ascribed to the

fluo-silicic acid, led me to put them to the test of experiment, when I had the pleasure of finding the statement perfectly correct.

It thus appeared, that the fluo-silicic acid is a very useful precipitant of potash, when, either in a free, or combined state; and, since it was shewn to be capable, in the moist way, of taking potash even from sulphuric acid, *a fortiori*, it would also decompose the chlorate of potash, and thus afford a ready means of separating the acid of that salt, the process for obtaining which was before both tedious and expensive.

My next object was, of course, to obtain the fluo-silicic acid in quantities: the requisite mixture of powdered fluate of lime, fine sand, and sulphuric acid was therefore put into a flask, and by means of a glass tube, twice bent at right angles, the fluo-silicic acid gas was passed into distilled water.

But in this mode of operating, the orifice of the tube was quickly choaked by an abundant deposition of silica, and the gas soon ceased to pass through the water.

As this method of proceeding was not attended with success, in all subsequent operations, instead of immersing the tube, conveying the acid gas, into the water, I merely brought it within half an inch of the surface of the liquid; when the gas, from its great weight, fell down upon the water, and was absorbed in large quantities; while its excess of silica was precipitated in abundance.

Having thus obtained a strong solution of fluo-silicic acid in water, it was then my object to procure it of a definite strength, and to ascertain its equivalent by saturating with it a given quantity of the carbonate of potash, obtained by heating the bi-carbonate of that alkali in a platinum crucible; but these previous steps were unnecessary, as I afterwards found, that by means of a solution of fluo-silicic acid of unknown strength, the chloric acid could be detached from its combination with potash, and obtained pure by the following process. Mix a warm solution of the chlorate of potash, with one of fluo-silicic acid; heat the mixture moderately for a few minutes, and, to ensure the perfect decomposition of the salt, add a slight excess of the acid, which may be ascertained by its property of being wholly deprived of its silica, by an

aqueous solution of ammonia. By this means, the chlorate of potash will be entirely decomposed; the mixture will become slightly turbid, and fluo-silicate of potash will be precipitated abundantly in the form of a gelatinous mass. The supernatant liquid will then contain nothing but chloric acid, contaminated with a small quantity of fluo-silicic acid; it is to be filtered, and the whole of the chloric and fluo-silicic acids are then to be neutralized by carbonate of barytes, and the chlorate of that earth, after having been obtained in crystals by filtering and evaporating, the solution is to be redissolved in a small quantity of water, and decomposed by the cautious addition of sulphuric acid, in the manner originally recommended by M. Gay Lussac. It is unnecessary to expatiate on the importance of chloric acid: the fluo-silicic will perhaps also become a useful instrument of analysis.

Yours &c.

JAMES LOWE WHEELER.

St. Bartholomew's Hospital, 11th December.

Art. XIII. *Table exhibiting the average Quantity of Spirit in different Kinds of Wine. By* W. T. Brande, *Esq. Sec. R. S. &c.*

Since the publication of the researches upon the state of spirit in fermented liquors, contained in the Philosophical Transactions for the years 1811 and 1813, I have through the kindness of different friends had ample opportunities of extending my experiments, and to my former list of wines, already copious, a few additions have been made, of which I have from time to time given notice, and which are put down in the following table. It does not seem necessary, in this place, to allude to the experimental details, nor to notice the precautions required in conducting the distillations, as these are fully given in the Papers above noticed, I have therefore omitted the column, which will be found in the Philosophical Transactions (1811, page 345.) shewing the specific gravity of the distilled liquor, upon which the calculations are founded.

	Proportion of Spirit per cent. by measure.
1. Lissa	26,47
Ditto	24,35
Average	25,41
2. Raisin wine	26,40
Ditto	25,77
Ditto	23,20
Average	25,12
3. Marsala	26, 3
Ditto	25, 5
Average	25, 9
4. Madeira	24,42
Ditto	23,93
Ditto (Sercial)	21,40
Ditto	19,24
Average	22,27
5. Currant wine	20,55
6. Sherry	19,81
Ditto	19,83
Ditto	18,79
Ditto	18,25
Average	19,17
7. Teneriffe	19,79
8. Colares	19,75
9. Lachryma Christi	19,70
10. Constantia, white	19,75
11. Ditto, red	18,92
12. Lisbon	18,94
13. Malaga (1666*)	18,94
14. Bucellas	18,49
15. Red Madeira	22,30
Ditto	18,40
Average	20,35
16. Cape Muschat	18,25
17. Cape Madeira	22,94
Cape Madeira	20,50
Ditto	18,11
Average	20,51
18. Grape wine	18,11
19. Calcavella	19,20
Ditto	18,10
Average	18,65
20. Vidonia	19,25
21. Alba Flora	17,26
22. Malaga	17,26
23. White Hermitage	17,43
24. Rousillon	19,00
Ditto	17,26
Average	18,13
25. Claret	17,11
Ditto	16,32
Ditto	14,08
Ditto	12,91
Average	15,10
26. Malmsey Madeira	16,40
27. Lunel	15,52
28. Sheraaz	15,52
29 Syracuse	15,28
30. Sauterne	14,22
31. Burgundy	16,60
Ditto	15,22
Ditto	14,53
Ditto	11,95
Average	14,57
32. Hock	14,37
Ditto	13,00
Ditto (old in cask)	8,88
Average	12,08
33. Nice	14,63

* See vol. i. p. 136, of this Journal.

	Proportion of Spirit per cent. by measure.		Proportion of Spirit per cent. by measure.
34. Barsac	13,86	44. Elder wine	9,87
35. Tent	13,30	45. Cyder, highest average	9,87
36. Champagne (still) ...	13,80	Ditto lowest ditto ...	5,21
Ditto (sparkling) ..	12,80	46. Perry, average of four samples	7,26
Ditto (red)	12,56	47 Mead	7,32
Ditto (ditto)	11,30	47. Ale (Burton)	8,88
Average	12,61	Ditto (Edinburgh) ...	6,20
37. Red Hermitage	12,32	Ditto (Dorchester) ..	5,56
38. Vin de Grave	13,94	Average	6,87
Ditto	12,80	49. Brown stout	6,80
Average	13,37	50. London Porter (average)	4,20
39. Frontignac	12,79	51. Ditto small beer (ditto)	1,28
40. Cote Rotie	12,32	52. Brandy	53,39
41. Gooseberry wine	11,84	52. Rum	53,68
42. Orange wine,—average of six samples made by a London manufacturer.	11,26	53. Gin	51,60
43. Tokay	9,88	54. Scotch Whiskey	54,32
		55. Irish ditto	53,90

Art. XIV. *Experiments to determine the Constitution of liquid Nitric Acid, and the Law of Progression followed in its Densities, at successive Terms of Dilution. By* Andrew Ure, *M. D., Professor of the Glasgow Institution.*

Though nitric acid has been employed for nearly 800 years in the most important chemical operations, and though its general composition was clearly demonstrated by the Hon. Mr. Cavendish, in the very dawn of pneumatic chemistry, yet the exact proportion of its two constituents, azote and oxygen, is a problem which seems hitherto to have baffled the best directed efforts of modern science. M. Gay Lussac states, as its

composition in 100 parts, 30.4 azote + 69.6 oxygen; and Mr. Dalton 26.7 azote + 73.3 oxygen. Thus discordant are the latest determinations. I hope soon to be able to present to the public some researches, which may possibly tend to clear up this mystery.

The constitution of the *liquid* acid, which forms the subject of the present communication, is involved in, perhaps, still greater obscurity and contradiction. Dr. Henry, in the last edition of his valuable Elements, says, "We have not, however, at present, documents sufficient for the construction of an accurate table, of the quantities of *real nitric acid*, in acids of different densities."* Of the truth of this statement, we shall be abundantly convinced, if we compare together the results of the most eminent modern chemists. At the specific gravity of 1.500, Mr. Kirwan gives 68 as the quantity of dry acid in 100 parts of the liquid; Sir H. Davy, at the same density, gives 91; Dr. Wollaston 75, and Mr. Dalton in his last corrected account, on which "he thinks full reliance can be placed," 68.†

How Mr. Dalton formed his new table, published by Dr. Henry, is not stated; but, in my humble apprehension, it exhibits internal proofs of inconsistency and error. I here subjoin it, with two columns of differences, which will, I presume, justify the preceding assertion.

Acid per cent. by weight.	Specific Gravity.	Differences of acid to 0.010 sp. gr.	Differences of sp. gr. to 1 of acid.
84.9	1.62 ?		
73.8	1.55 ?	1.60	0.0063
65.2	1.48 +	1.23	0.0081
58.4	1.44	1.70	0.0059
53.0	1.41	1.80	0.0055
48.4	1.39	2.30	0.0043
44.5	1.36	1.30	0.0077
41.3	1.33	1.60	0.0062
20.0	1 42	1.07	0.0093

These successions of very unequal and irregular differences, corresponding each to successively *equal* differences of specific

* Vol. 1. p. 364. † Ibidem.

gravity or acid will not accord with any experimental series or hypothetical progression which I know.

I have made very numerous and diversified experiments to decide this important point, and have obtained results of the most desirable consistency. From regular prisms of nitre, I procured, by slow distillation, with concentrated oil of vitriol, nitric acid; which by the tests of nitrate of silver and of barytes, was found to be absolutely pure. Only the first portion that came over was employed for the experiments. It was nearly colourless. Its specific gravity was 1.500. A re-distilled and colourless nitric acid, prepared in London, was also used for experiments of verification, in estimating the quantity of dry acid in liquid acid of a known density.

The above acid of 1.500, being mixed in numbered phials, with pure water in the different proportions of 95+5, 90+10, 80+20, &c. I obtained, after due agitation, and an interval of 24 hours, liquids whose specific gravities at 60° Fahrenheit were determined, by means of an accurate balance, with a glass globe and narrow neck of known capacity. Table I. column 2d, presents these experimental results. In Table II. the intermediate terms are interpolated by the law of progression, which I had the good fortune to discover.

The composition of nitre was determined both by analysis and synthesis; and the proportions obtained from these opposite sources agreed very well, being nearly 53 of dry acid and 47 of potash in 100 parts. I shall content myself with giving the details of my last experiment, in the conduct of which every precaution was observed requisite to ensure precision of result. 40 grains of subcarbonate of potash, from tartar, recently ignited, were introduced into a small pear-shaped vessel, with a long and narrow neck. The orifice was closed with a hollow stopper, terminating above and below in a tube almost capillary to prevent the ejection of liquid matter during the effervescence. 406.4 grains of dilute nitric acid, sp. gr. 1.054, containing $\frac{1}{10}$ of that whose density was 1.500, were poured in by slow degrees. By litmus paper, there was now found to be an excess of acid, which was very exactly neutralized by 1.7 gr. additional, of subcarbonate. The weight of the whole contents, including

a little water which had been employed to wash down and dissolve the carbonate, was 1292 grs. The sp. gr. of this saline solution at 60° was 1.031. Being evaporated very slowly, in in a platina capsule, on a regulated sand-bath, it afforded 61 grs. of perfectly dry nitre.

I then took 240 grs. of purified nitre, and dissolving them in water, in a vessel of known weight, I diluted the solution till its sp. gr. at 60° became 1.031, when I found that the whole liquid weighed 5080 grs., of which 240 were nitre, and 4840 water; or in the 100 parts, 4.724 of the former, + 95.726 of the latter. Hence if 100 contain 4.724, then 1292 will contain 61.03; being an excellent accordance with the preceding result by evaporation.

41.7 grs. of subcarbonate of potash yield, by my instrument for the analysis of the carbonates, 13.094 carbonic acid + 28.606 potash. Therefore 61 grs. of nitre consist of 28.606 base + 32.394 acid; or in the 100 parts 46.9 of the former, + 53.1 of the latter. And if 406.4 of the dilute acid = 40.64 of that whose density is 1.500, yield 32.394 of dry acid, 100 will contain 79.71. I am confident that this number 79.71, represents very nearly, if not exactly, the per centage of real acid in liquid nitric, sp. gr. 1500; provided pure nitre contain no water of composition, as is now generally agreed on. It is remarkable, that 79.71 differs very little from the mean of the two widely discordant results of Sir H. Davy and Mr. Dalton; for $\frac{91+68}{2} = 79.5$.

In column 1st of the following table, the per centage of liquid nitric acid sp. gr. 1.500 is given, in correspondence with the successive densities of column second, as determined by experiment. Column 3d shews the series of differences of sp. gr. for each successive decade, or equal difference of dilution. They gradually augment down to 30, where they arrive at a *maximum*. In column 4th I have presented the mean density computed from those of the components, by the rule given in my paper on mean sp. gravity, in the last number of the Journal of Science and the Arts. Column 5th exhibits the resulting volume, or the degree of condensation, produced in the union

of the above strong acid and water. It consists of the quotients obtained by dividing each number in the 4th column, by the parallel number in the 2d. The 6th column is the quantity of dry acid in 100 parts; and the last, or 7th, presents the numbers deduced from the law of progression, and shews its accordance with actual experiment, or with the progression of nature.

The sp. gravity of dilute acid, containing 10 parts in the 100 of that, whose density is 1.500, is 1.054. Taking this number as the root, its successive powers will give us the successive densities, at the terms of 20, 30, 40 per cent. Thus $1054^2 = 1.111$, is the sp. gr. corresponding to 20 strong acid +80, water; $1054^3 = 1,171$, is that opposite to 30 acid + 70 water; and $1.054^4 = 1,234$ is the sp. gr. at 40 per cent. of the strong liquid acid. The specific gravities, therefore, are a series of numbers in geometrical progression, corresponding to the terms of dilution, another series, in arithmetical progression, exactly as I have shewn with regard to sulphuric acid. Hence if any one term be given, the whole series may be found.

In column 5th we observe, that the maximum condensation of volume takes place, at 46 dry acid + 54 water. Above this point, the curve of condensation has a contrary flexure; and therefore, a small modification must consequently be made, on the root 1.054, in order to obtain with final accuracy, in the higher part of the range, the powers which represent the specific gravities. This modification is however extremely simple. To obtain the number for 50 per cent. the root is 1.053; and for each decade up to 70 inclusive, it must be diminished by 0.002. Thus for 60, it will become 1,051; and for 70, 1.049. Above this, we shall obtain a precise correspondence with experiment, up to 1500 sp. gr. if for each successive decade we subtract 0.0025 from the last diminished root, before raising it to the desired power, which is the per centage of liquid acid.

When we inquire, more minutely, into the peculiarity attending the above compound of greatest density, we shall find it, to consist of 7 atoms of water = 79.24, united to one atom of dry acid = 67.5; which is the ratio of 54 to 46, as

given above. But the acid atom results from 5 atoms of oxygen, combined with one of azote. Therefore, in that liquid compound, each atom of oxygen, is associated with one of water, arranged alternately, round the central atom of azote to the upper and under surface of which, the two remaining aqueous atoms, may be supposed to be attached. The symbol, exhibiting this atomic structure, may be easily figured by those, who have paid the least attention, to the symmetrical disposition of spherical particles. It may be inferred that in this arrangement, and happy proportion, the acid and water exert their reciprocal attractions, to most advantage; whence results the *maximum* condensation.

TABLE I. of Nitric Acid.

Liq. acid in 100.	Sp. gravity by Experiment.	Differences to 10 of liq. acid.	Mean sp. gr. of Components.	Resulting volume.	Dry acid in 100 of liquid.	Series of powers.
100	1.5000	———	1.5000	100	79.7	1.501
95	1.4875	———	1.4634	98 38	75.715	1.488
90	1.4725	0.0275	1.4286	97.02	71.730	1.473
80	1.4383	0.0342	1.3636	94.80	63.760	1.438
70	1.3970	0.0413	1.3043	93.36	55.790	1.398
60	1 3490	0 0480	1.2500	92.66	47.820	1.348
55	1.3214	———	1 2245	92.66	43 835	1.3214
50	1 2920	0.0570	1 2000	92.88	39.850	1.2945
40	1.2330	0.0590	1.1538	93.58	31.880	1.2340
$33\frac{1}{3}$	1.1905	———	1.1250	94.50	26.566	1.1910
30	1.1710	0.0620	1.1111	94.89	23.91	1.1710
20	1.1110	0.0600	1.0714	96.43	15.94	1.1110
10	1.0540	0.0570	1.0346	98.0	7.970	1.0540
5	1.0277		1.0170	99.00	3.985	1.0270

These experimental specific gravities, first found by direct mixture of the strong acid and water, in successive proportions, were further verified in several of the points, by the addition of water or acid in definite quantities, to acid which had already suffered a known degree of dilution. The numbers obtained, in these somewhat independent modes, coincided perfectly with each other.

TABLE II.

Exhibiting the proportion of real or dry Nitric Acid in 100 *parts of the Liquid, at successive specific gravities.*

Specific gravity.	Acid in 100	Specific gravity.	Acid in 100.	Specific gravity.	Acid in 100.
1.5000	79.700	1.3783	52.602	1.1833	25.504
1.4980	78.903	1.3732	51.805	1.1770	24.707
1.4960	78.106	1.3681	51.068	1.1709	23.910
1.4940	77.309	1.3630	50.211	1.1648	23.113
1.4910	76.512	1.3579	49.414	1.1587	22.316
1.4880	75.715	1.3529	48.617	1.1526	21 519
1.4850	74.918	1.3477	47.820	1.1465	20.722
1.4820	74.121	1.3427	47.023	1.1403	19.925
1.4790	73.324	1.3376	46.226	1.1345	19.128
1.4760	72.527	1.3323	45.429	1.1286	18.331
1.4730	71 730	1.3270	44.632	1.1227	17.534
1.4700	70 933	1.3216	43.835	1.1168	16.737
1.4670	70.136	1.3163	43 038	1.1109	15.940
1.4640	69.339	1.3110	42.241	1.1051	15.143
1.4600	68.542	1.3056	41.444	1.0993	14.346
1.4570	67.745	1.3001	40.647	1.0935	13.549
1.4530	66.948	1.2947	39.850	1.0878	12.752
1 4500	66.155	1.2887	39.053	1.0821	11.955
1.4460	65.354	1.2826	38.256	1.0764	11.158
1.4424	64.557	1.2765	37.459	1.0708	10.361
1.4385	63 760	1.2705	36.662	1.0651	9.564
1.4346	62.963	1.2644	35.865	1.0595	8.767
1.4306	62.166	1.2583	35.068	1.0540	7.970
1.4269	61.369	1.2523	34 271	1.0485	7.173
1.4228	60.572	1.2462	33.474	1.0430	6.376
1.4189	59.775	1.2402	32.677	1.0375	5.579
1.4147	58.978	1.2341	31.880	1.0320	4.782
1.4107	58.181	1.2277	31,083	1.0267	3.985
1.4065	57.384	1.2212	30.286	1.0212	3.188
1.4023	56.587	1.2148	29.489	1.0159	2.391
1.3978	55.790	1.2084	28.692	1.0106	1.594
1.3945	54.993	1.2019	27.895	1.0053	0.797
1.3882	54.196	1.1958	27.098		
1 3833	53.399	1.1895	26.301		

Whatever modification future researches may chance to make, on my fundamental or initial quantity, 79.7; the above table of densities, corresponding to successive per cen-

tages of *liquid* nitric acid, sp. gr, 1.500, being deduced from accurate experiments, will, I presume, be permanently useful. We shall in that event, require merely to change a little the primitive number; which being multiplied by 99, 98, 97, &c. will give products, representing the proportion of dry acid, corresponding to the above specific gravities.

In my paper on sulphuric acid, published in the last number of this Journal, it is shewn that 73 parts by weight of concentrated oil of vitriol, combined with 27 of water, suffer a greater condensation of volume, than when mixed in any other proportions; 100 parts in volume become 92.14. I have since ascertained that this proportion also gives the greatest elevation of temperature. 1460 gr. of acid $= 73 \times 20$, and 540 of water $= 27 \times 20$, each at 60°, suddenly mixed in a thin glass capsule, whose weight was 564 gr. raised the thermometer to 260°. 1720 gr. acid $= 86 \times 20 + 280$ water $= 14 \times 20$, gave on mixture a heat of 224°; and 1460 acid $= 60 \times 20 + 800$ water $= 40 \times 20$, gave in like circumstances a heat of 242°. We thus perceive a beautiful relation, between the degree of condensation, and the evolution of caloric. We see, that at 86, or 13 per cent. *above* 73, the point of *maximum* density of dilute acid, less heat is evolved than at 60, or 13 per cent. *below* it; for the curve of rarefaction undergoes a less rapid flexure in the latter equal interval, than in the former. At 60° the resulting volume is only 92.87, while at 86, it is 92.95. In like manner I have found that when $58 \times 10 = 580$ gr. of nitric acid, sp. gr. 1.500, are mixed with $42 \times 10 = 420$ water, both at 60°, the temp. rises to 140°; being a greater elevation than can be produced with any other proportion. The resulting volume is here a *minimum*; 100 parts have become 92.65.

To complete my Table of sulphuric acid, I shall now subjoin, the specific gravities of distilled and re-concentrated oil of vitriol, diluted to successive terms, till I found a coincidence to take place, between the numbers thence resulting, and those derived from the dilution of genuine commercial acid, as formerly given.

Liquid Acid in 100.	Sp. gr.	Dry Acid in 100,
100	1.846	81.54
95	1,834	77.46
90	1.807	73.39
85	1.764	69.31
80	1.708	65.23
75	1.650	61.15

In a paper on muriatic acid, inserted in the Annals of Philosophy for last November, I have stated, that if the decimal part of the number, representing the specific gravity of the liquid acid, be multiplied by 148, the product will be very nearly, the quantity per cent. of dry acid. The multiplier 147, will give a still better approximation.

Glasgow, Dec. 9, 1817.

Art. XV. *A System of Chemistry, in four volumes,* 8vo. *by* Thomas Thomson, *M. D. F. R. S &c. The fifth edition. London,* 1817.

In a System of Chemistry, the first thing we naturally look for is *system*: we look for " a scheme which unites many things in order," " written or formed with regular subordination of one part to another." The utility of such a work depends mainly, we might say wholly, upon such an arrangement; its purport should be to assist the memory by its connection, and to afford the greatest facility of reference by its simplicity. The art of arranging is perhaps one of the most difficult tasks of the philosopher, and one on which a variety of opinions has always existed. It is however pretty generally allowed that if, with reference to abstract perfection in the sciences, a natural synthetical order be most perfect, an artificial analytical method is most adapted to the varying circumstances of their progression. The student at his entrance on his study should have as little as possible presented to his attention substances with which he is not familiar, and to the knowledge of which he has not been led by any previous acquisition. On this important point we are at decided variance with the author of the work now before us. He informs us, in his

preface, that the arrangement which he has formed appears to him " better adapted to convey a clear idea of the present state " of the science in all its bearings to the Tyro who is just " commencing the study of chemistry, than any other which " he has seen." To us, on the contrary, it appears to be complicated and confused, and such as no beginner in the science could possibly understand. It is bad in its conception, and involved in its details. He has not given us the grounds for an opinion at least self-sufficient: but we shall endeavonr as briefly as possible to justify our dissent.

Dr. Thomson divides his work into two parts, the first of which comprehends the *Science of Chemistry properly so called,* and the second consists of a *chemical examination of nature.* Now if the *Science of Chemistry* mean any thing at all, it means, in our humble conception of the words, a *chemical examination of nature.* Dr. Thomson's own definition of the word Chemistry is, " that science which treats of those events or changes in *natural bodies,* which are not accompanied by sensible motions." This division, then, is tautological, and if adhered to, implies repetition. And in fact, one of the greatest faults of the book is constant repetition, which is only avoided in places by the worse expedient of reference and counter-reference. Almost every page would afford us an example of this defect. We will dip at hazard: " Iron combines with two proportions of " sulphur and forms protosulphuret, and persulphuret of iron, " compounds which are usually distinguished among minera- " logists by the names of magnetic pyrites and cubic pyrites.

" If we suppose the first a compound of 1 atom of iron + 1 " atom of suphur, &c." " the second 1 atom of iron + 2 atoms " of sulphur, &c."—" Protosulphuret of iron or magnetic py- " rites is found native in considerable quantity. Its colour is " that of bronze. It has a metallic lustre. Its specific gra- " vity is 4.518.

" Persulphuret of iron, or cubic pyrites, is of a yellow co- " lour and has the metallic lustre. Its specific gravity is " about 4.5. It usually crystallizes in cubes."—Vol. 1. p. 384, et. seq.

" As far as has been hitherto observed, pyrites consist

" essentially of two distinct species. 1. Magnetic pyrites com-" posed of 1 atom of iron and 1 atom of sulphur. 2. Cubic " pyrites composed of 1 atom iron and 2 atoms sulphur. The " first is a sulphuret, the second a bisulphuret of iron. Mag-" netic pyrites is of a *bronze* yellow colour. Internal lustre " shining metallic. Spcific gravity 4.518. Common pyrites; " colour bronze yellow; massive and crystallized in cubes. " Lustre from splendant to shining, metallic. Specific gravity " 4.830." Vol 3. p. 469, et seq.

In this example, which is one amongst a thousand, we have a complete repetition in the third volume of the properties of sulphuret of iron detailed in the first volume, and almost in the same words. Others of its characters are divided between the two sections in a manner highly confused and inconvenient. Thus, the analysis of the different varieties of native pyrites is given under the head of iron and its compounds, in the first volume, and totally omitted in the mineralogical part in the third volume, while its crystallizations, fracture, &c. are noted in the latter, and neglected in the former.

In the same way the acetous fermentation in the 4th vol. is divided from acetic acid, and the formation of vinegar in the 2nd vol; and no better illustration can be given than these two sections afford of the inconveniences arising from the primary division of the subject.

Dr. Thomson next subdivides the *science of chemistry properly so called*, into three parts: 1. A description of the component parts of bodies, or of *simple substances*, as they are called. 2. A description of the compound bodies formed by the union of simple substances. 3. An account of the nature of the power which produces these combinations.

This is the exact inversion of the order which we should conceive best adapted to convey a knowledge of chemistry to those who are just at their entrance of the study. To the beginner it presents utter unintelligibility, and to those who are more advanced, inexplicable confusion.

Our author has somewhere told us, that " beginners will " find it convenient to peruse the two following chapters be-" fore they read the remainder of this section." We cannot

help thinking, that it would have been wise to have enlarged this direction, as we are quite sure, that beginners will find it not only more convenient, but absolutely necessary, to read Book iii. of the First Part, before they attempt to understand Books i. and ii. The first two books relate entirely to the results of affinity, or of its antagonist powers, and yet we are not told what affinity is, till the Third Book. We are told in the first volume, that *decompositions* are owing to the *attractions* existing between bodies and the respective electricities; but it is not till the third volume that we are informed what attraction and composition are.

In the *first* volume we are instructed, that "Berzelius has "contrived a theory of combustion and of *chemical affinity*, "which has a very plausible appearance, and which has been "embraced, either entirely, or with some modifications, by se-"veral of the most eminent chemists of the present day. "According to him, all bodies which have an *affinity* for each "other, are in two opposite states of electricity, and the more "intensely each is excited, the stronger is their *affinity* for "each other." In the *third* volume it is explained, that "the "term *affinity*, as at present used, signifies the power by which "the ultimate particles of bodies are made to unite together, "and kept united.

Again.—What is a beginner to understand from the following method of introducing the atomic theory?—"Now if "we make 1.00 represent the weight of the smallest particle "of oxygen which can unite with a body, we shall find after-"wards, that the smallest quantity of chlorine that can com-"bine with a body, will be represented by 4.5. Hence we "may conclude, that protoxide of chlorine is a compound of "one atom of chlorine and one atom of oxygen." And thus through the whole range of simple bodies and their compounds, numbers are attached to the different substances, which must be totally insignificant to the uninformed student, till at the end of all he is told, what ought to have been impressed upon him at the beginning, and what could alone have induced him to give importance to the calculations, that "the same proportions of bases that saturate a given weight

"of one acid, saturate all the other acids; and the same pro-
"portion of acids that saturates one base saturates all the other
"bases. Hence numbers may be attached to each acid and
"base, indicating the weight of it, which will saturate the
"numbers attached to all the other acids and bases.

It appears to us, that it would have been at once a more natural and intelligible method of proceeding, to have explained the powers productive of phenomena, before enumerating the phenomena themselves, and to have attached meanings to terms, before employing them in the communication of ideas.

The separation of simple bodies and their compounds, is also highly injudicious and embarrassing. If we were in the habit of meeting with the undecompounded bodies in their isolated state; if oxygen, and hydrogen, and chlorine, and potassium, &c. were substances daily presented to our view, without the assistance of the art which it is one of the objects of this work to teach, that is to say, in short, if the course of nature were totally different from what it is, such a classification might have its advantages; but as it is, some knowledge of the compound is actually necessary even before we can obtain the element, and the principal properties, and many of the characteristic differences of the latter are only to be defined by reference to the former. This sub-division, therefore, naturally produces the same consequences of repetition and reference which we have before deprecated as the result of the primary division of the work. Let us take, for example, the following complete chapter on the chlorides.

CHAPTER II.—*Of Chlorides.*

"Chlorine appears capable of combining with all the simple
"combustibles, except carbon. These compounds (unless
"they possess acid properties) are called chlorides. They are
"analagous to the oxides, and are probably as numerous as
"those bodies. But it is only a few years since they became
"known to chemists as a distinct class of bodies. On that
"account, it is not surprising that they have not yet been

" all examined. I thought it better, in the present state of " our knowledge, to describe the different chlorides, while " treating of their various bases. The reader, therefore, will " find an account of them in the chapter which treats of " *simple combustibles* "

The section on *metallic oxides* (a sufficiently comprehensive title) consists of little better than one page, for which the excuse is,—" I have already described the properties of these " oxides, and given a table of their composition, when treating " of the metals themselves from which they are obtained."

We will select one whole section, and a chapter more, without fearing to burthen our pages, or cramp ourselves for space."

SECTION II.—*Of Chloriodic Acid.*

" This acid has been described at sufficient length in a " former part of this work. It does not appear capable of " combining with bases. Whenever a base was presented to " it, water was always decomposed, and muriatic acid and " iodic acid formed."

CHAPTER III.—*Of Iodides.*

" In the present state of our knowledge of these bodies, I " thought it better to describe them while treating of their " different bases. An account, therefore, of all of them with " which we are unacquainted (acquainted, we presume) will " be found in the chapter on simple combustibles."

Instances on the side of redundance and repetition, it would be tedious to particularise: they are to be met with in almost every section. The composition of water is given in vol. i. under the head of Hydrogen, and again in vol. ii. under the title Water. The experiments of Priestley and Cavendish, by which they composed nitric acid from the atmospheric air, are detailed at page 209 of vol. i. and separately at p. 81 of vol. ii. The formation and properties of carbonic acid are recorded almost as minutely in treating of carbon, as in the chapter appropriated to their description, &c. &c. &c.

'In short, the whole *System* is so very complicated, chiefly

from the causes which we have pointed out, that it may be considered as any thing but "formed with regular subordi-"dination of one part to another."

We must now proceed to the details of the work, in which, to judge from our marginal marks, we shall find much matter for discussion.

Dr. Thomson, after shortly introducing his subject, and dividing it as before stated, addresses himself to the consideration of the properties of *imponderable* bodies, a term which he has very properly substituted in this edition for *unconfinable* bodies in others. He briefly enumerates the properties of light, and fully recounts the experiments which elucidate the nature of heat. We were here much startled with his chapter on combustion, and we must be allowed a few observations on a subject of such primary importance. He defines the term combustion, properly enough, we conceive, "a total "change in the nature of combustible bodies, accompanied "by the copious emission of heat and light." But we little expected to see it stated, at the present day, that M. Lavoisier explained completely the first of these phenomena, by *demonstrating, that in all cases, oxygen combines with the burning body*. And again:—"He fully established the existence "of this general law. In every case of combustion, oxygen "combines with the burning body":—and elsewhere; "ac-"cording to the theory of Lavoisier, which is now almost "generally received and considered by chemists, a full expla-"nation of the phenomena, combustion, &c." We must own, that we had imagined that, so far from this being the case, not one person entitled to the name of a chemist, was to be found to defend, as a general law, a proposition obviously at variance with fact and experiment. Our author, however, fortunately for his fame, as a chemist, though with some detriment to his character for consistency and accuracy, is at decided variance with himself, for he afterwards admits, without any prefatory explanation, and without in any way previously modifying the axiom which he has promulgated, that there are *three* substances, the presence of one or other of which *is absolutely necessary, in order that combustion may take*

place. These three bodies are oxygen, chlorine, and iodine. The compounds which they make with each other and with azote are likewise supporters of combustion.

Allowing for the nearer approximation to truth by the enlargement of the limits, we are inclined to believe that this amended proposition is equally indefensible upon general principles with that originally set forth, and so easily abandoned. We know of many instances of combustion in which none of the bodies allowed by Dr. Thomson to be supporters, either simple or compound, are present. As for instance, in the formation of many of the sulphurets and phosphurets, and in some of the combinations of potassium, light and heat are out given in abundance. Indeed we should have thought that consistent with the state of our present knowledge, but one definition of combustion could have been admitted, and that the same given us by our author, viz. the combination of bodies with the extrication of heat and light; and that if a cause were required of the phenomena, the only one we could assign would be *intense chemical action.*

It is curious to observe the shifts to which the Doctor is forced in endeavouring to extricate himself from the dilemma to which he is reduced by the narrowness of his own definition. Speaking of the very instances to which we have alluded, he says. " Sulphur and phosphorus combine with the " metals and with some of the earths. The combination is " not formed without the assistance of heat. This melts the " sulphur and phosphorus. At the instant of their combi- " nation with the metallic or *earthly* bases, the compound " becomes solid, and at the same time suddenly acquires a " strong red heat, which continues for some time. In this " case the sulphur and phosphorus *act the part of a supporters,* " for they are melted, and contain a great deal of caloric; " the metal or earth acts the part of a combustible; for both " contain light as a component part. The instant of combi- " nation the sulphur or phosphorus combines with the metal " or earth; while the caloric of the one uniting to the light " of the other, *flies off in the form of fire.* The process there- " fore may be called *semi-combustion,* indicating by the term

"that it possesses *precisely one half* of the characteristic marks "of combustion."

We verily believe that we have read this passage a dozen times, with the vain hope of being able to attach some rational meaning to the words, and we have since read it more than once for the express purpose of ascertaining whether our author was really in earnest in propounding such crude notions to the scientific world. Were we not well assured that he is a grave man, and but little given to unseasonable joking, we should almost be inclined to suspect some waggery.* What! "by combustion is meant a total change in "the nature of combustible bodies accompanied by the copious "emission of heat and light," and yet here are two combustibles which combine with total change of properties acquiring "a strong red heat, and the caloric of the one uniting to the "light of the other flying off in the form of fire," and this is not combustion,! but semi-combustion.! Things equal to the same are no longer equal to one another, and we may estimate *precisely* that this process only possesses one half of the characteristic marks of combustion, because we call it semi-combustion.

While upon the subject of combustion, flame and heat, we cannot avoid noticing the total omission of any reference to the important and curious experiments of Sir Humphry Davy upon these subjects lately published in the Philosophical Transactions. This is a very serious omission in a work which professes to "introduce every new fact and to present the "science in its most recent state" We are unwilling to suppose that these laborious inquiries, which have thrown so

* Not but that the Doctor sometimes indulges in a little drollery, of which the following note may be taken as a specimen: "This is the name (hydro-sulphuric acid) by which Sir H. Davy distinguishes common sulphuric acid *of the shops*. But such a distinction is surely unnecessary, as every *body* is aware of the presence of water in that *body*. Were Sir Humphry's method to be *followed out*, we should say *hydro-alcohol*, *hydro-sulphate of soda*, *hydro-soap*, *hydro-sugar*. In *short* we should *lengthen out* nine-tenths of all chemical names by prefixing to them the two syllables *hydro*. Vol. II. p. 673.

much new light upon the general principles of this abstruse subject, and have led to such estimable practical results, have been classed with those facts which were "not of suffi-"cient importance" to call for any change in the work while "passing so rapidly through the press." And yet we know not to what else to attribute the omission, unless indeed the very fact of "passing so rapidly through the press" is to be the excuse for this and other symptoms of neglect.

On the subject of electricity we are again at variance with our author. It was with no small degree of surprise that we found it asserted that the foundation stone of this science consists in there being two kinds of electricity, and that Dufay's original opinion concerning the vitreous and resinous fluids seems to correspond better with the phenomena, and to lead to fewer perplexing consequences than the theory afterwards substituted for it by Dr. Franklin. We addressed ourselves eagerly to the perusal of the arguments which we expected to follow, and to the detail of experiments which were to subvert a prejudice by which our minds were strongly biassed. We however shortly found that the subject was dismissed with much less trouble, and the premises taken for granted in the Doctor's usual (if we may be allowed the expression) *off hand* manner. "These and many other topics," we are told, "will find their place in another work which our "author intends to publish hereafter on electricity and Galva-"nism." On the present occasion we must adopt the example set us, and meet assertion by assertion. "The recent disco-"veries made in the science by the invention of the Voltaic "pile" do *not* seem to us "to agree much better with the "theory of Dufay than with that of Franklin." It is little short of absurd to adopt the complicated agency of two causes, where one is sufficient for the explanation of the effects; it is quite unphilosophical to suppose the existence of two fluids, where the phenomena prove only the existence of one. The details on which we found our conviction will find their place in another review which we *intend* to publish upon the work which our author *intends* to publish hereafter, on electricity and Galvanism.

One capital error we must likewise notice on this subject which would be likely not only to affect the theory of the science, but would prove of serious practical inconvenience to any one who should be incautious enough to consult Dr. Thomson alone on these matters. " It has been ascertained," he says, " that the energy of the electric pile, *at least, as far as* " *chemical phenomena are concerned*, increases in proportion to " the size of the pieces." This is decidedly a mistatement. As far as concerns the perfect conductors, such as metals, charcoal, &c. the *heating* power of the plates increases indeed with their size, but their power of *decomposition* upon imperfect conductors follows no such law. The agency of Mr. Children's enormous battery in chemical decomposition was scarcely perceptible.*

We now proceed to the consideration of ponderable bodies. And first upon the subject of chlorine, we feel it to be our duty to correct some misrepresentations which tend to affect the just appropriation of the honour of what we have always considered one of the most acute and important controversies of chemical science. The subject is divided according to the usual inconvenience of the general arrangement between the article Chlorine in the first volume and the article Muriatic Acid in the second volume. Few chemists, we are told, were disposed at first to accede to the opinion that oxymuriatic acid contained no oxygen, and we well remember that Dr. Thomson was one of the most persevering but not the most temperate defenders of the old doctrine, and his conviction is now acknowledged with not the most becoming grace. The misrepresentation of which we complain is contained in the following extracts.

" The first great addition to the discoveries on the nature " of oxy-muriatic acid were made by Gay Lussac and The- " nard, and published by them in 1811. They shewed that " the opinion that oxy-muriatic acid contains no oxygen " might be supported. An abstract of these important expe- " riments had been published *however* in 1809. These expe- " riments drew the attention of Sir Humphry Davy to the

* Philos. Trans. 1809. p. 32.

" subject, and he soon after communicated a paper to the " Royal Society, to show that no oxygen gas could be se- " parated from oxy-muriatic acid, nor any proof adduced that " it contained oxygen." Vol. 1, p. 185.

" The curious experiments on chlorine by Gay Lussac and " Thenard, the new view of the nature of muriatic acid taken " in consequence by Sir Humphry Davy, &c." Vol. 2, p. 72.

" This opinion was neglected for many years but was revi- " ved again in 1810 by Sir Humphry Davy, in consequence " chiefly of the experiments of Gay Lussac and Thenard." Vol. 2, p. 229.

The tendency of these passages is obviously to divide the merit of this reformation of theory between the French chemists and Sir Humphry Davy, whereas the experiments of the former, of which Sir Humphry Davy's opinions are stated to be the mere consequence, had no reference to the subject, and the original idea of Scheele was only incidentally mentioned, to be refuted. The theory of chlorine was never asserted to be a discovery.—But it was more—it was the re-establishment of an old opinion, against the strongest tide of prejudice, and for this we are indebted *solely* to the experiments and inductions of Sir Humphry Davy. The authority of M. Thenard himself is conclusive upon this head: " On pouvait expliquer " tous les phénomènes qu'il nous présente en le regardant " comme un corps simple ou comme un corps composé. *Ce-* " *pendant, cette dernière opinion leur parut plus vraisemblable.* " M. Davy, au contraire, embrassa la première, l'admit exclu- " sivement, et chercha à la fortifier *par des expériences qui lui* " *sont propres.*" Thenard, Traité de Chimie, Tome 1, p. 585.

Could we bring ourselves to believe that there were any thing but inadvertence in this, we should not content ourselves, as we now do, with barely correcting the misrepresentation.

Intimately connected with the subject of ponderable bodies, and essentially interwoven with it, is the doctrine of definite proportions. Every page of our author bears some reference to this important law. We have formerly expressed our opinion of the high advantages of this great discovery of modern

days, but we have also protested strongly against its misapplication and abuse.* In exact proportion to its efficacy, in discovering and establishing truth, if cautiously applied, is its power of begetting and perpetuating error if strained beyond the limits of experimental induction.

We must own that we were almost disheartened, upon turning our attention particularly to this part of the subject, in the work before us, to find that all the numbers that had hitherto been determined were likely to turn out fallacious. We have stumbled in the very threshold of the inquiry, and even our standards of comparison have been miscalculated. The specific gravity of oxygen, as deduced by Dr. Prout, from "considerations which," we are informed, "cannot be explained "here, is 1.1111." Dr. Prout has also shown, likewise, as the consequence of considerations which, we presume, could not be explained, *from the specific gravity of ammoniacal gas*, which is composed of three volumes of hydrogen and one of azote condensed into two volumes, that the specific gravity of hydrogen must be 0.0694, therefore water is composed by weight of

Oxygen - - -	8 - -	1.0
Hydrogen - - -	1 - - -	0.125

instead of the usually received proportions of

Oxygen - - -	7.5 - -	1.0
Hydrogen - - -	1.0 - -	0.132

"Dr. Prout, guided by theoretic reasons which cannot be "stated here, considers 2.500 as the true specific gravity of "chlorine," instead of 2.400, the mean before determined. Dr. Thomson is also "disposed to adopt the number 0.9722 fix- "ed upon by Dr. Prout from theoretical considerations which "he cannot explain here," as the true specific gravity of azotic gas.

Now we are never much disposed to prefer *theoretical considerations* to the results of actual experiment, much less theoretical considerations without explanation. We therefore immediately turned to the page referred to in the Annals of Philosophy, in search of the reasons for which it has been thought

* Journal of Science, Vol. 1, p. 287.

necessary to change every number in the hitherto received tables of chemical equivalents.

Dr. Thomson has not thought proper to give them, but we must, or we fear that our readers would suspect us of trifling with their credulity.

" Oxygen and azote.—Chemists do not appear to have con-" sidered atmospheric air in the light of a compound formed " upon chemical principles, or at least little stress has been " laid upon this circumstance. It has however been long " known to be constituted by bulk of four volumes of azote " and one of oxygen; and if we consider the atom of oxygen " as 10 and the atom of azote as 17.5, it will be found by " weight to consist of one atom of oxygen and two atoms of " azote, or per cent. of

Oxygen	22.22
Azote	77.77

" hence then it must be considered in the light of a pure che-" mical compound. From these data the specific gravities of " oxygen and azote (atmospheric air being 1 000) will be " found to be

Oxygen	1.1111
Azote	.9722"

Here it will be observed there are no fresh arguments stated to induce chemists who do not consider atmospheric air in the light of a compound formed upon chemical principles, to correct that opinion, but the matter is taken for granted; and it is curious to observe the cross application of the calculations of the two doctors. Dr. Prout deduces the specific gravities of oxygen and azote from the weights of their atoms 10 and 17. 5, allowed by Dr. Thomson; and Dr. Thomson calculates the weights of the atoms from the specific gravities determined by Dr. Prout. " Nitric acid is composed of $66\frac{2}{3}$ volumes of " azote and $166\frac{2}{3}$ of oxygen. Now these volumes being con-' verted into weights give the composition of nitric acid

Azote	1.75
Oxygen	5.00"

And this our author terms his reason for *pitching* upon 1,75 to represent the weight of an atom of azote.

Dr. Prout's *theoretical consideration* for correcting the number for chlorine appears to us more extraordinary still.

"The specific gravity of muriatic acid, according, to Sir "Humphry Davy's experiments, *which coincide exactly with "those of Biot and Arago*, is 1.278. Now if we *suppose* this "specific gravity to be *erroneous* in the same proportion that "we found the specific gravity of oxygen and azote to be "above, the specific gravity of this gas will come out about "1.2845." Neither do we understand the propriety of determining the specific gravity of hydrogen gas, from the specific gravity of ammoniacal gas. To us it appears that the sources of error in calculating from a body composed of three volumes of hydrogen and one of azote condensed into two volumes are much more numerous, (taking more particularly into consideration the nature of that body) than any which could arise from the old method. Perhaps the following quotations from the two Doctors, who have hitherto so happily gone hand in hand together, may illustrate our opinion.

"*It is obvious from this* that ammonia is composed of three "volumes of hydrogen and one volume of azote compressed "into two volumes, hence its constituents by weight are,

Hydrogen	0.1947
Azote	0.9722

"*Thus we see that ammonia is a compound of three atoms of hy-"drogen and one atom of azote.*" Thomson, Vol. i. p. 129.

"Thus ammonia has been stated to be composed of one "atom of azote and three of hydrogen, *whereas it is evidently "composed of one atom of azote and only* 1.5 *of hydrogen*, which "are condensed into two volumes, equal therefore to one "atom." Prout, Annals of Philosophy, Vol. vi. p. 330.

Who shall decide when Doctors disagree?

To us the additional reason given by Dr. Prout, that, "thus "the specific gravity of oxygen as obtained above is just six-"teen times that of hydrogen as now ascertained, the specific "gravity of azote just fourteen times, and the specific gravity "of chlorine exactly thirty-six times," is quite unconvincing. We always have a jealousy of these *just* numbers.

If we were to suppose all Dr. Thomson's reasoning to be trifling in the same proportion as that which he has adopted from Dr. Prout, we should be tempted to give up our task in despair; but we must hope better things, and proceed.

We know not that we can in any way better impress the caution which we wish to give as to precipitancy in determining chemical equivalents, than by placing in two columns a list of numbers as laid down by Dr. Thomson within the space of three years. It is not that we would quarrel with him for correcting his opinions; but the fact is, that they are nine-tenths of them calculated upon insufficient data, and the corrections are not supported by any arguments, or likely to prove at all more correct than the original series,

	System of Chemistry 1817.	Annals of Philosophy 1813, 1814.
Oxygen	1.0	1.0
Chlorine	4.5	4.4
Azote	1.75	0.878
Hydrogen	0.125	0.132
Phosphorus	1.5	1.320
Arsenic	4.75	6.000
Sodium	3.00	5.882
Barium	8.75	8.731
Strontium	5.5	5.900
Magnesium	1.5	1.368
Yttria	5.0	8,400
Glucina	3.25	3.600
Alumina	2.115	3.500
Iron	3.5	6.666
Nickel	3.375	3.623
Cobalt	3.625	7.326
Manganese	{ 3.5 3.75	7.130
Zinc	4.125	4.315
Lead	13.0	25.974
Tin	7.375	14,705
Bismuth	8.875	8.994
Silver	13.75	12.618
Platinum	22.625	12.161
Antimony	5.625	11.111

When it is recollected that these are all simple or undecompounded bodies, the confusion arising from their combination is too easily conceived to need description.

Many of these discordant numbers are actually derived from the same data, and they are all laid down in an authoritative manner, which would appear to admit of no appeal. For example :—"We know of two oxides of iron; the first "composed of 100 metal + 30 oxygen, the second of 100 "metal + 45 oxygen. Hence the first *must be a deutoxide.*" —Annals Phil. vol. ii. p. 48.

"Thus we obtain 28.57 for the quantity of oxygen which "unites with 100 of iron, in order to constitute protoxide of "iron: *we see from this,* that the protoxide is a compound "of 1 atom iron, and 1 atom oxygen, and that an atom of iron "weighs 3.5."—System, vol. i. p. 370.

Again.—"From the experiments of Davy, and of Gay "Lussac and Thenard, it appears, that soda is a compound "of 100 sodium and 34.1 oxygen, and the peroxide of sodium "of 100 sodium and 51.1 oxygen. Hence it follows, that "soda *must be a* compound of 1 atom of sodium and 2 atoms "of oxygen. These data give us the weight of an atom of "sodium 5.882."—Annals of Phil. vol. ii. p. 46.

"Hence soda is composed of sodium 100 + oxygen 33.3. "If we consider soda as a compound of 1 atom sodium and "1 atom oxygen, the *weight of an atom of sodium* will be 3.0." —System, vol. i. p. 329.

These contradictions are sufficiently amusing, but it is more entertaining still, to see the Doctor himself puzzled amidst his incongruities. In the table, it will be observed, that two very different numbers are given as the equivalent for arsenic, viz. 4.75 and 6.000. Dr. Thomson says, "let us suppose "that the oxygen in this number is represented by 2.5. In "that case, the weight of an atom of arsenic will be 4.75, and "arsenic acid will be a compound of Arsenic 4.75
Oxygen 2.45

"Now this is almost exactly the mean of the experiments "of Proust and my own. *I am therefore disposed to consider "it as accurate.*"—System, vol. i. p. 297.

Five pages further on, he says, "the result of his experi-"ments (Laugier's) was, that sulphuret of arsenic artificially "prepared, is composed of Arsenic 58
Sulphur 41¾

" Now this approaches to a compound of 1 atom arsenic, " with 2 atoms sulphur,"—evidently forgetting the number 4.75, which he has just determined, and assuming as correct the number 6.0, as laid down in the Annals of Philosophy.

Who shall decide when a Doctor disagrees with himself?

But we need not travel out of the book before us for contradictory numbers. In vol. i. p. 248, we find, " therefore " boracic acid *must be* composed of Boron 0.66
Oxygen 2.00

" This deduction, which is probably near the truth, agrees " best with the first experiment of Davy. We see from it, that " the weight of an atom of boron is 0.66.

At page 309 of the same volume, the number for boron is given 0.875.

Does Dr. Thomson understand the meaning of an equivalent? We assure our readers that the question is quite justifiable. Having given 3 5 as the number for iron, and 4.5 as the number for its protoxide, he adds, " the equivalent num- " ber (for the peroxide) we perceive, is $3\frac{1}{3}$." To be sure, he does subjoin, " this appears, at first sight, absurd:" but we maintain, that it is not only at first sight, but that the more it is examined, the more absurd it appears. " The peroxide," he continues, " contains more oxygen than the protoxide, " and yet its equivalent is less;" and he then, perversely enough, deduces the right number by the following calculation, upon the supposition that it is a compound of 2 atoms iron + 3 atoms oxygen;—" then the weight will be " 3.5 + 3.5 + 3. = 10."

It would be easy to fill a whole number of our Journal, by exposing similar inconsistencies in this System of Chemistry. Enough, however, has been done to justify the recommendation which we would again give, of less precipitancy and less peremptoriness in determining chemical equivalents. Let chemists make more use of their crucibles and furnace, than of their pen and ink. The man who, by one accurate analysis, makes us acquainted, experimentally, with the constituents of a single compound, is entitled to more thanks than he who, by calculation, forces the whole cata-

logue of chemistry into the trammels of a theory, and does more towards establishing the theory, if it be worth preserving.

Dr. Thomson is not always equally sceptical, nor does he hold his judgment in suspense upon some occasions, as he does upon others. His caution in receiving new ideas, as suggested by the discovery of Sir H. Davy's safety lamp, is a complete contrast to the eagerness which he has displayed to admit the wonderful products of Dr. Clarke's blow-pipe. We are even now informed, that "lately, Dr. Clarke has decom-"posed barytes, by exposing it to an intense heat, produced "by the combustion of a stream of oxygen and hydrogen gas, "mixed together in the requisite proportions to form water. "He has given to the metal of barytes the name of *plu-"tonium*."

He even proceeds to give the characters of "*barium thus "obtained.*" We never doubted the power of this blow-pipe to produce intense heat, and still less have we doubted, that the Cambridge Professor has been able to reduce the oxides of certain refractory metals, when intensely heated upon charcoal; but we have more than *theoretical considerations* to induce us to believe, that the highly inflammable metals of the earths, never were yet produced in an intensely heated state in an atmosphere of which oxygen was an indispensible ingredient, by the sole energy of heat.

But Dr. Thomson, though disposed to go a mile with Dr. Clarke, will not go two, for we are told, that "silica may be "subjected to a very violent heat, without undergoing any "change." His ideas, however, of this substance, are sufficiently peculiar. It is an acid! and it is actually placed between carbonic acid and phosphoric acid. Upon perceiving this, it immediately occurred to us, that our author's ideas of an acid must be very peculiar, and we turned directly to the chapter which treats of acids, to ascertain what they were. Here we found, that "the word acid was originally synony-"mous with *sour*, and applied only to bodies distinguished by "that taste:" and we also found, that three out of four of the distinctive properties of acids were, that "when applied "to the tongue, they excite that sensation which is called

" sour, or acid. They unite with water in almost any pro-" portion. They change the blue colours of vegetables to " a red."

These words could scarce have been dry from the Doctor's pen, or if cut out of an old edition to serve the purposes of a new one, the paste must still have been wet with which they were adjusted to their places, when we are informed, that silica is an acid, and that the silicic acid is a fine pow-" der, *without either taste or smell*, that it is *insoluble in water*, " except when newly precipitated, and then 1 part of it is " soluble in 1000 parts of water, and that it has *no effect* on " vegetable colours."

But then, " Mr. Smithson suggested, that in its compounds, " silica performs the function of an acid; an opinion which " has been demonstrated in a satisfactory manner by Berzelius." Of this *satisfactory demonstration*, we have before had occasion to speak pretty fully,* and as to performing the functions of an acid, (if we understand the term) so do phosphorus, sulphur, &c.

Dr. Thomson's notions of an alcali seem equally confused, indefinite, and peculiar, for we are told, at page 313, vol. i, that *oxide* of tellurium, possesses both the properties of an *acid* and *alcali*. And again, to our infinite surprise, gold, platinum, palladium, rhodium, and iridium, constitute the fifth family of *alkalifiable combustibles*. This made us rather curious to know what had become of the acidifiable metals, when after some rummaging, we found them in a separate genus of *intermediate combustibles*. —Vol. i. p. 528.

While upon this subject, we think it right to notice the difficulties that beset us, on consulting the scattered fragments of the article Manganese, upon which we happened to be making a few experiments, at the time of writing these pages. First, Dr. John says, " there are three oxides, which " are composed as follows," &c. Then, Dr. John acknowledges, " that his analyses of these oxides is by no means to be

* See Journal of Science, vol. i. p. 226.

depended on." Then, Dr. Thomson tells us something we cannot understand, about the "green oxide of John," and the "intermediate oxide of John." Then comes Berzelius, who "partly from his own experiments, and partly from those of "John, *reckons* five oxides." Then, "Berzelius's statements "are rather theoretical than experimental. He even doubts "the existence of his first oxide, *the only one he examined.*" Then Dr. Thomson tells us, that "in reality, his *third* oxide is the *protoxide* of manganese."—Vol. i. p. 403, &c.

At length, by the help of the index, we found what we wanted, namely, the method of separating iron from manganese, at p. 611, vol. iii, and were surprised to meet with the clumsy mode by acetic acid and evaporation, instead of the preferable process by neutralisation with ammonia, devised by Mr. Hatchett, and communicated by that gentleman to the Annals of Philosophy.—Vol. ii. p. 343.

But we are exceeding our limits, and must abridge our remarks. We may probably be induced to take up the subject of *compound bodies* in some future number, if the press of more important matter should allow us. The subject is sadly encumbered with a heap of new substances and unconfirmed discoveries, which should not have found their place in a System of Chemistry, till better authenticated.—Such are, boletic acid,—rheumic acid—sorbic acid—zumic acid—medullin—pollenin, &c.

Of the general principles of chemistry, so entirely misplaced in the third volume, we have not much to say. After having gone through the whole subject, and given the primitive forms, and many of the crystallizations of the different substances, as they occurred, we are at length told what a primitive form is, and what is meant by crystallization, in a very meagre sketch of M. Haüy's theory. The marginal figures in this part of the work, are miserably executed, and scarcely sufficient to answer their intended purpose. Only one figure of a crystal is given in the whole four volumes, and this is of carbonate of soda. Why this substance has been so particularly distinguished, we are at a loss to

conceive. One such is, however, quite sufficient, for it is inaccurate in outline, and almost unintelligible in effect.

No mention whatever is made of the theory of spherical atoms, notwithstanding the experimental form which the subject has lately assumed; and we should have thought that Mr. Daniell's experiments, which have been totally omitted, might have thrown some light not only upon this subject but upon that of affinity in general.

In the art of chemistry and in practical details, this edition, so far from being improved is even behind the others. The processes for obtaining many of the substances described, are not mentioned at all, or but very slightly alluded to, and those which are given are mostly insufficient in details, and inadequate to teach the *modus operandi* so essential to learners. We instance the articles iode, potassium, sodium, and the important process of cupellation.

Upon the subject of nomenclature we are pretty well agreed with Dr. Thomson, though we are totally at a loss to understand the meaning of the following passage of his preface: " Sir Humphry Davy has invented a nomenclature of " his own, but I am not aware that he has obtained hitherto " any followers in this country; unless Dr. Davy and Mr. " Brande constitute exceptions to the observation." Of this nomenclature we have never heard—the rest of the observation is not worth remark.

We would not, if we could help it, part with our author on bad terms: but the fact is, we have been woefully disappointed in our expectations. The work displays great reading, and what is of infinite importance, the reference to authorities is full and complete. It is a book which every chemist must have, but with which we fear that every chemist will be dissatisfied. We agree that " the revolution in chemistry, toge- " ther with the great number of new ideas and new names " that have been introduced in consequence of Davy's new " views respecting the nature of chlorine and muriatic acid, " of the discovery of iodine, and of the knowledge of cyano- " gen and its compounds, by the sagacity of Gay Lussac, *had* " thrown a certain degree of obscurity over the science, and

"*had* given it that unsettled fluctuating appearance which is "apt to discourage those who are commencing the study." We agree, we say, with this in every thing but the expression in the past tense. The evil still exists, wholly unabated; and the work is yet to come which shall fully detail the principles and processes of chemistry "with regular subordination of "one part to another."

Art. XVI. *Report on Mr.* Millington's *Lectures in the Royal Institution, containing an Account of the late Improvements in the Manufacture of Hemp and Flax, and of the Machinery used therein.*

Continued from page 148 of this Volume.

The next object of enquiry in these Lectures, was the nature of those motions which the human body can most readily impart, and the purposes to which they are particularly applicable; as well as the reasons why machinery is incapable of performing all those operations which the hand of man can effect, on account of some requiring the exertion of mind and skill, as well as mere force or power. In all equable actions, when a constant and uniform force is only necessary, machinery is capable of being applied, and from the equality of its action will generally perform its duty with more regularity and perfection than can be expected from manual labour: thus in the raising or lowering of weights, the grinding of corn, the rolling and cutting of iron, in weaving, and in many other instances, machinery is more effective than human exertion, as indeed it will no doubt prove in every case, when brought to sufficient perfection: thus, the art of spinning threads certainly seems to demand considerable attention from the spinner, that the same quantity of material may at all times be given out, by which alone the thread can be kept even in dimensions and strength, and this, till within the last few years, was thought to be an operation completely out of

the reach of machinery, although it is now carried on almost without superintendance, and with a degree of perfection which a century ago would have been deemed chimerical. The steam engine likewise, by a similarity of perfection in the mechanic arts, is now brought to such a nicety of action in its various parts as to be surpassed only by organized beings.

Some of the simplest applications of human power were enumerated in this place, such as the applications of strength to raise weights by different means. Several varieties of cranes for raising goods, were shewn and described, particularly Mr. D. Hardies', as it is used in the East India warehouses, and which, although a walking crane, is perhaps one of the safest, and at the same time most efficient applications of power which has been devised. Its general construction is similar to that of the common walking crane, but its parts may be made much smaller, because the workmen do not operate on the inside of the wheel, but on its outside, by means of narrow float boards similar to those of an undershot water-wheel, and which pass through a floor situated on a level with the centre of the wheel. Upon this floor the men stand, and when in action, they hold by a strong rail placed a little above their heads, which prevents their falling, and tread upon the boards in succession, thus bringing them down to the level of the floor. By this means the whole weight of the man, or men, is brought into action at the extreme radius of the wheel, and in a direction perpendicular to the resistance to be overcome, by which the greatest effect is produced; and should the resistance at any time prove superior to the weight of those employed against it, they can instantly increase their effective power by bearing upwards against their resting bar, or completely stop the crane by placing the foot upon a lever on the floor for that purpose. One of the best contrivances about this crane, and which deserves to be particularly noticed on account of its great utility in many other situations, is the water regulator, for regulating the velocity of all bodies in their descent, and thereby preventing many accidents. This consists of a well-bored pump barrel or cylinder, with a close top and bottom, having a strong metal tube of large

dimensions communicating from its top to its bottom. A cock is placed in some part of this connecting tube, by the opening and shutting of which all exterior communication between the top and bottom of the cylinder may be cut off. A solid plunger or piston of metal works within this cylinder, by means of a strong piston-rod passing through a stuffing-box in the top of it, and this pump being filled with water, oil, or any incompressible fluid, it is evident the piston will be incapable of moving unless the cock of communication in the tube be open, when during the descent of the piston all that part of the fluid which is below it will pass by the lateral tube to the upper part of it, and vice versâ; while if the cock be totally or partially closed, the fluid will either be entirely prevented passing to the opposite sides of the piston, or may be made to do it so gradually, by a species of wire-drawing process, that a descending body may be regulated to any assigned velocity. The end of the piston-rod is connected by slings, or other means, to a crank fixed either upon the main shaft of the crane itself, or upon some of the shafts of the cog wheels connected with the crane (if any are used), so that no revolution can take place without causing the piston to move in its cylinder.

The next species of machinery examined was that for manufacturing processes, in which some degree of skill is necessary in addition to mere strength or motive power; and although many examples of this kind might be selected, yet the manufacture of linen and other fabrics having lately received some important improvements, which were not at that time immediately before the public; and the culture and preservation of Flax and Hemp being objects which appeared to Mr. Millington to offer the most speedy and efficient means of affording profitable employment to the many thousands of labouring poor who then stood in need of such assistance, was selected and entered upon with considerable detail, and for similar reasons we shall now give a more particular account of this part of our subject than of others, considering that it may be of essential importance to the community at large.

Mr. Millington, after giving an account of a number of

experiments which had been made upon the relative strength and utility of the nettle, the hop, the aloe, the yucca, the barks of the mulberry and bread-fruit tree, and many other vegetable fibres for the production of thread, cloth, and paper, concluded by observing that the hemp, the flax, and the cotton were superior to them all, not only on account of their abundance and easy culture, but from the very superior strength and fineness of their fibres under all changes of circumstance.

The hemp being the larger and stronger plant, yields the longest, coarsest, and strongest fibres, and is usually employed in forming all kinds of ropes and cordage, coarse cloth and sacking, notwithstanding which, if properly dressed and managed, a white linen may be produced from it very little inferior in texture to that of flax, and certainly superior in durability. Flax, on the contrary, being a more tender and delicate plant, produces a finer fibre by ordinary treatment, and is used for the finer fabrics of thread, linen, and cambric.

The treatment of Hemp and Flax from the time of their growth up to their formation into thread and cloth, is so similar that a description of the operations performed on the one will answer for both: our present observations will therefore be confined to those of flax, and in order that the advantages and importance of the recent improvements in dressing or preparing this article might be the more obvious and intelligible, an account of the common usage and practice was given, which we shall state in nearly the Lecturer's own words.

The flax plant (*Linum* of Linnæus) is an annual, requiring to be sown with seeds of the last year's produce, from the second week in March to the middle of April. It prefers a free open loam, which is neither subject to too much wet or drought: is certain of producing a good crop on new ground, and will generally thrive on any soil which is proper for barley or oats. It remains on the ground till the end of July, or middle of August, when it ripens, and is fit for pulling,*

* This should be done soon after the bloom falls off, when the stalk begins to turn yellow, and before the leaves fall off.

(unless it should, from circumstances, be desirable to keep it for seed only) and may be succeeded by a crop of wheat or turnips, for which it is an excellent preparation. It may also be sown to advantage with clover seeds, which will then succeed it as an after-crop. Hemp (*Cannabis sativa*) is a much more rank and coarse plant, growing from six to sixteen feet in height, and is more or less common in all countries. It is, however, chiefly cultivated in the northern parts of Europe, whence it is largely imported into England. It thrives well in England; and English hemp, when properly manufactured, is found more compact, strong, and durable than that of Russia. It should be sown about the same time as flax, in a deep, rich, and moist soil, on which account the Isle of Ely and the fens of Lincolnshire are particularly favourable to its growth Like flax, when sufficiently ripe, it is not cut but pulled up root and all, on which account both these plants leave the soil particularly clean.

The next operation is to obtain the useful fibre from these plants. It is situated between the interior wood and exterior bark of each stalk, and has always been obtained by an aqueous decomposition, or by rotting away the wood and exterior bark by exposure to moisture, since the fibre itself (though no doubt somewhat injured by the process) has sufficient strength and durability to withstand it in a great measure. The process of rotting away the woody, from the fibrous parts of plants, is one of extreme antiquity, it being noticed in the sacred writings, and having been used, not only in this country, but on the Continent, from time immemorial. Notwithstanding which, it has proved extremely detrimental to the health not only of the inhabitants but the cattle of those countries in which it is carried on to a considerable degree, and is a system which, on this account, it would be highly desirable to abolish. It becomes the source of many pestilential diseases, among which perhaps the Malaria, so prevalent in the vicinity of Rome and Naples, may be numbered; besides which, since flax and hemp ripen about the month of August, and require to be submitted to this process as soon as they are taken from the ground, or at least before they

dry, the farmer's attention becomes necessary to them at a time when it is most valuable and can least be spared, namely, in the time of, or immediately antecedent to his corn harvest.

The product to be expected from the growth of flax is of two kinds, viz. The seed for oil and sowing, and the fibre for spinning. These are nearly equal in value, and it has been usual for cultivators to govern their operations by the kind of crop which is produced; thus, if it grows short and branchy, the seed will be more valuable than the flax, which consequently should not be disturbed until that seed is perfectly ripe; while, on the contrary, if it proves tall, and has not fallen, the seed (although not ripe) is excellent food for cattle, and must be threshed out as perfectly as possible, and the remainder sacrificed to the fibre. A very good machine for thrashing out flax, in this state, by Mr. Cleall, was shewn, and will be found described in the Transactions of the Society for the Encouragement of Arts and Sciences, London, Vol. xxv. p. 143.

The operation of rotting, or, as it is generally called, Water Retting Flax and Hemp, is one of considerable nicety, and hazard to the cultivator, on which account it has, in all probability, proved a much greater barrier to the cultivation of these useful plants in England than the alleged exhaustion of soil, or any other cause; for its perfection, and the period when it should cease, depend on several fortuitous circumstances, which may dispose the woody matter of the stem to decompose with greater or less facility. Thus it will be influenced by the strength and vigour of the plant, the moisture or dryness of the season, the temperature of the air during the process, as well as the soil from which the plant was produced. If the operation is carried too far, not only the woody matter but the fibre also will be destroyed or injured, and if not far enough, it has generally been thought that the flax will not dress; and thus after a good crop has been produced, it may be much injured, if not spoiled, in the incipient stage of its manufacture.

The steeping or watering of flax, is most commonly performed in artificial ponds or canals, excavated by the sides of

rivers, and generally about 40 feet long, 6 feet wide, and 4 deep, a sufficient size to admit the produce of an acre of land at once.—Sluices are so disposed, that the contained water may at any time be let off, and a fresh quantity of water, which should be soft, admitted. These canals should be exposed to the sun, which assists the decomposition. The fresh gathered flax being tied in bundles or handfuls, is carefully placed in these reservoirs, the superior bundles causing those which were first deposited to sink; and in this way each reservoir is filled, but not to such a degree as to force any part of the flax to touch the bottom; and when filled, the whole surface is covered with close hurdles or boards, and sufficiently loaded with stones to cause every part of the flax to be under the surface of the water. In this state it is left, and occasionally examined, to ascertain how far the process of decomposition is completed, which will generally be within a fortnight. The bundles of flax, which have by this time become very tender and difficult to handle, are now to be taken out on boards or trays, and removed on to the nearest short grass or heath, where they are regularly disposed in rows to loose their moisture, and in which situation they receive an additional preparation from the evening dews and occasional showers, completing the decomposition, and at the same time washing away the slime and mucilage with which they are mixed. This last exposure is called dew-retting, and continues, according to the state of the atmosphere, for four or five weeks, or until the flax is as dry as it can be got, of a clear good colour, and all the woody matter which remains is perfectly brittle. The fibre will still retain most of its original tenacity, if the operation has been carefully and skilfully conducted. It is then carried away, like hay, on a fine dry day, and deposited in barns, being now ready for the next process, called breaking and dressing.

So soon as a reservoir is emptied as above described, its water is let off, of course in a very putrid and unwholesome state. The basin is washed out; a new quantity of water is admitted, which is now ready to receive a fresh charge of flax. The rivers, by receiving this water, particularly if hemp

has been steeped in it, become contaminated; their fish are killed; the cattle refuse to drink it; and the atmosphere around, is filled with noxious vapours, most detrimental to the health of the inhabitants. Such is the state of the flax and hemp countries during the time of its harvest and preparation: and no wonder can exist, that crops so precarious and so detrimental, not only to the population, but so exhausting to the soil, should have, in a great measure, been excluded from Great Britain, where, notwithstanding the high profit these articles carry, the importation is almost universally pre- to the home production of them.

The breaking of flax is the separation of what is technically called *the Boon*, or woody matter, from *the Harle*, or useful fibre; and this may be effected in a variety of ways. It is done in mills by machinery, and by hand, and in almost all cases, is very effectually performed by a set of blunt iron teeth or breakers, fixed upon one piece of wood and met by another similar set of teeth fixed to a moveable piece, which is worked by the one hand, while the flax in handfuls, is introduced between these teeth in various directions with the other hand. This breaks and knocks off the greater part of the wood in small fragments called chaff, and the operation is completed by *scutching* or beating the flax against a smooth post called a scutching post, and also beating it with an instrument, somewhat resembling a curry-comb, and called a hand scutch, by which the few remaining fragments of wood or boon are taken away, and nothing but the long fibre remains, which is now to be hackled, or drawn by the hand over a species of comb, having a great number of very sharp long and perpendicular steel points upon it, by which any remaining boon, and the short fibres or tow are removed, and the long fibres which remain are regularly disposed, and ready to pass into the hands of the spinner.

Flax and hemp have obtained the character of being very impoverishing crops to the land which bears them, and very deservedly so. From the above account of their treatment, it is impossible they should be otherwise: for while every other crop makes a return to the land, either of its roots or

branches to decay, and form manure, or becomes matter of animal food; these make no such return, at least to their own land. They are taken up root and all; they are exposed to decomposition in water, which dissolves and carries away into lower situations, all that which, in other plants, becomes vegetable nutriment, and the chaff which is produced by breaking, is refused by all cattle, as containing no nutriment either for them or the vegetable kingdom; all therefore is lost, except the fibre and the small portion of seed which remains when the fibre is preserved; which circumstances in no small degree tend to deteriorate the value of the crop which would otherwise be produced.

After the unfavourable view which has just been taken of this subject, it may seem not a little surprising to assert, that the system which has been followed for ages, although fraught with so many difficulties and disadvantages, should, in the course of the last few years, have been subverted and supplanted by one which, though in its infancy, seems to promise the most flattering prospects to the world, and to remove every disadvantage which had formerly been complained of.

It has been discovered, that the process of steeping and dew retting, as applied to flax and hemp, is wholly unnecessary; and that these vegetables will not only dress, but will produce an equal, if not greater, quantity of more durable and serviceable fibre, when treated in the dry way, than when exposed to the tedious, difficult, and precarious process which has been above described; and it is to be lamented, that a discovery of so much national importance, made in this country, should not hitherto have been recorded and described in any of her journals or archives of science.

This discovery was first given to the world by James Lee, Esq. formerly of Old Ford, in Essex, and now of Merton Abbey Flax Mills, he having obtained a patent for his process in 1812, under the singular protection of a special act of Parliament, which permitted the specification of that patent invention to remain sealed up for seven years, contrary to the general practice in such cases. It is impossible, therefore,

to gather what the particulars of this invention may be, except only so far as Mr. Lee has thought proper to divulge them for the purpose of carrying his invention into effect, and by which it appears to be for his dry preparation of flax and hemp, and for the machinery he uses to prepare it; and from such parts of his process as have thus come before the public, he certainly is entitled to its warmest gratitude; for although it has been contended, that the dry preparation of these vegetables was known and practised before his time, yet no positive proof has been adduced of these circumstances: his patent stands unmolested; and when it is known, that he is the first who has, with indefatigable zeal and industry, stepped forward to try and prove the merits of this process by long and extensive trials and experiments, the tongue of envy ought surely to lay still, and if it cannot dispute his right to the invention, it ought, at least, to yield him all that praise which is due to him for having turned the attention of mankind towards so valuable an improvement.

Mr. Lee has ascertained, by such experience as puts the fact beyond all doubt, that when the hemp or flax plants are ripe, the farmer has nothing more to do, than to pull them as heretofore practised, to spread and dry them in the sun as he would his hay or grain, taking care only in the ridges to lay the roots in one direction, so as to prevent, as much as possible, the breaking or entanglement of the stems, and when sufficiently dry, to carry and lay them in store, either in ricks or in his barns. No preparation of a canal and running water; no loss of time; no hindrance from other harvest or business is necessary; and as the unripe seed and nutriment contained in the plant, are now no longer to be dissolved and washed away, these products, thus preserved, produce ample manure to make flax and hemp desirable, rather than impoverishing crops; for, according to Mr. Lee's statement, the unexhausted chaff and seed saved by the dry method of working flax, is fully equivalent, in food for cattle, to a crop of oats, and, consequently, the whole of the flax fibre produced from the stem, may be considered as costing nothing.

Among the more valuable concomitants of this discovery

are the circumstances of the noxious vapours and unhealthy employment attendant upon the former process of steeping flax being removed, as well as the supply of an abundance of in-door winter employment, being produced in the breaking and preparation of flax for spinning, when it has been thus husbanded, and which may be resorted to at all convenient times, when the farming labourers and servants are shut out from other work by the inclemency of seasons or other causes; and thus it is presumed a new source of active and lucrative employment is held out to the British farmer, by the adoption of which, he may in a few years be in the receipt of that immense capital which is now paid to foreign countries upon the importation of flax and hemp.

Valuable as this first part of Mr. Lee's discovery appears to be, he seems to have been less happy in the second, which relates to the machinery to be used for breaking and manufacturing the flax and hemp prepared by his dry method. His specification being still concealed from view, it is impossible to describe his machinery, except so far as it has come before the public in the use of his patent process, and by which it appears that the first machine he wished to be used was what he calls a Scraper, answering the purpose of rough breaking the boon or woody matter out of the stem and scraping off the exterior bark. This machine consisted of a piece of timber, supported like a stool, and firmly fixed to the ground at about $2\frac{1}{2}$ feet from it, and laying in an horizontal direction; upon one end of this stool were fixed a few blunt iron teeth, or breakers about eight inches long, in the direction of the length of the stool, and with their edges pointing upwards; another similar set of teeth were fixed in the same direction, but pointing downwards at the end of a lighter piece of timber, which at its opposite end was attached by a strong hinge or joint to the top of the stool, and above this a handle to lift it up or press it down by the left hand, while a handful of raw flax was held in the right hand, and introduced between the upper and lower set of teeth or breakers, where it was to be turned and moved backwards and forwards, and occasionally drawn from between the teeth, which were all

this while kept in a chopping action, and with a due degree of pressure so as not to cut or injure the *harle*, by the motion of the left hand. This machine so nearly resembles the common hand breaker which has long been used in all countries, that no representation of it is deemed necessary. When the flax had been sufficiently broken and scraped by this machine, it was carried to another, the Breaker, very similar in action, but rather different in form to the first. In this, one set of breakers or iron teeth were fixed to a short horizontal piece of timber, but instead of pointing upwards they were fastened to one side of it, their length still being in an horizontal direction. This bearer for the breakers had its two ends mortised into two strong upright posts of timber about two feet asunder, the bottoms of which were fixed to the floor and their tops to the ceiling of the room in which it was to work, the transverse piece carrying the breakers, being fixed at such height between them as to be conveniently under the hand of a person standing behind it to work it, and the breakers, which were more in number and smaller than in the first machine, were screwed into that side of the bearer farthest from the workman. The corresponding breakers were fixed upon another heavy piece of timber, supported by two side timbers very nearly fitting between the upright standards, and extending to near their tops, where these were fixed by two screw bolts, or a round rod of iron passing through the whole four, and serving as a hinge upon which this last apparatus might swing like the batten and swords of a weaver's loom, and to be worked in the same way, by a cross bar or handle, near the bottom to which the left hand was to be applied. The flax having passed the first machine, was now to be held by the right hand, permitting it to hang down over the breakers and bearer, while the second set of breakers were to be forcibly drawn against it by the other hand, and by a continuance of this operation, the fibre at length became freed from all the woody matter and bark, which fell to the ground, and upon being afterwards passed through a pair of finely fluted rollers was finished and ready for the hackle.

From the above description it will appear that there is little of novelty or invention in any of Mr. Lee's machines, the breaking process being very nearly similar to that which has been used both in Europe and America for ages past. The great inconveniences found to result from this machinery is the trouble and expense of fixing it firmly: the great loss of fibre which is sustained, particularly by the scraping process; and the length of time for which any given quantity of flax must be beaten before it is sufficiently clean to hackle; for which reasons the produce of these machines has been less profitable than could be wished; and although it is possible that other and more perfect machinery may be described in the specification, it is more than probable that this is not the case, since Mr. Lee has obtained another patent within the last two years for other machinery and processes not included in the first, and the specification of which is not protected by the same secrecy of inrollment. Mr. Lee thus appears to have been made fully satisfied, by experience, of the incapacity of his first machines to produce much work, and he therefore now abandons them, and performs his whole operation by means of a series of small iron fluted rollers, combined by pairs in frame work, working each in other's teeth or projections, and made to press or bear upon each other in any assigned degree, and so as to admit larger or smaller charges of flax between them, by means of levers and weights; and although the application of such fluted rollers to the breaking of flax and hemp has long been common, particularly in Scotland, yet Mr. Lee's arrangement of them is novel, ingenious, and perfectly answers the purpose.

Instead of using one or two pair, as usual, he proposes to dispose a number of single pairs of rollers by the side of each other, having them all kept in motion at once by a water wheel or other prime mover; and instead of passing the flax through them in its natural straight form, it is entered between them, and as soon as the ends appear and come out on the opposite side of the rollers, those ends which are following are intermixed or overlayed, or as it is technically called, *tailed on* to the first, so as to form a circular loop or

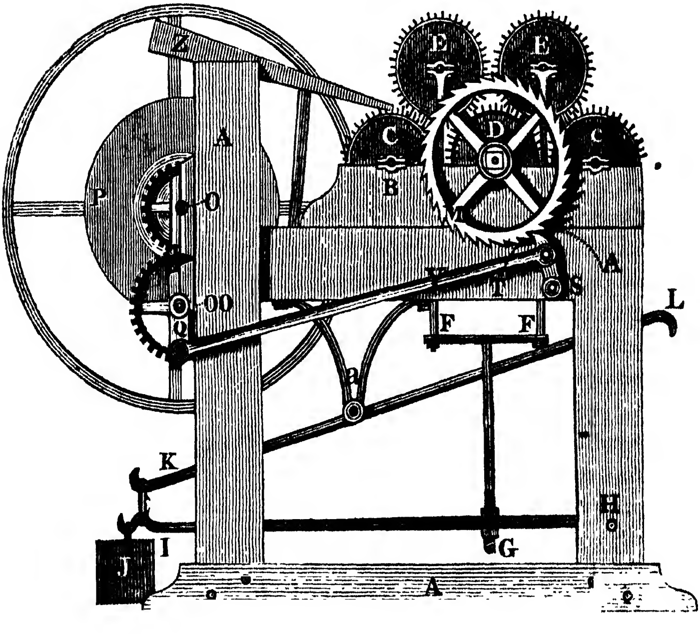
skein of flax, which having as it were no end, will continue to revolve between the rollers for any length of time. In this way, one child can attend to ten or a dozen pair of rollers, for having completed his first link of flax in the first pair, he proceeds and does the like in the second, third and so on, until he arrives at the tenth or twelth, by which time that link which was put upon the first roller, is sufficiently rubbed and cleansed; and by watching for the place of tailing on as it revolves, and gently disengaging it by a pull when it comes to the front, that quantity will run out, and must be replaced by a new one, and so of all the rollers in succession; by which means a very considerable quantity of flax is cleansed and dressed at a very small expense of labour, though at the same time it will be seen this application of machinery is not calculated to be put in motion by manual labour, but to give it its due effect, requires a powerful prime mover.

The importance of a cheap, effective, and expeditious mode of breaking and preparing raw flax and hemp, is such that it cannot be a matter of surprise that many ingenious mechanics should have turned their attention to this subject.—Several models of machines for this purpose were exhibited, amongst which were those of Mr. Bond and Mr. Durand, which will be found described in the Transactions of the Society for the Encouragement of Arts Manufactures and Commerce, Vol. 25, p. 152, and Vol. 31, p. 269; and especially those of Messrs. Hill and Bundy, of Camden Town, near London, for which Mr. Bundy had just obtained a patent for Great Britain and France, and which, from the novelty of their actions and motions, and the very speedy and efficacious manner in which they perform their work, deserve to be particularly noticed.

These machines are a Breaker and a Rubber.—The first being for the purpose of separating the harle from the boon, as usual, but by a new process: the latter for rubbing and subdivided the fibres so as to produce it in its greatest state of perfection, and finally cleansing it before it goes to the hackler. The breaking machine will be first described, as it is to be first used, and it will appear, that although it consists chiefly

of fluted or toothed cylinders, yet it varies from all other machines for the same purpose which have preceded it, by the inequality of the depth of its teeth, the play or space which exists between one tooth and another, and in the reciprocrating motion of the cylinders combined with their progressive motion, instead of its being progressive only, as in all former cases; by these means the happiest effects are produced. The simple manner in which this complex motion is brought about reflects the highest credit on the mechanical skill of Mr. Bundy, the inventor, not only of these machines, but of many others of equal ingenuity.

FIGURE I.

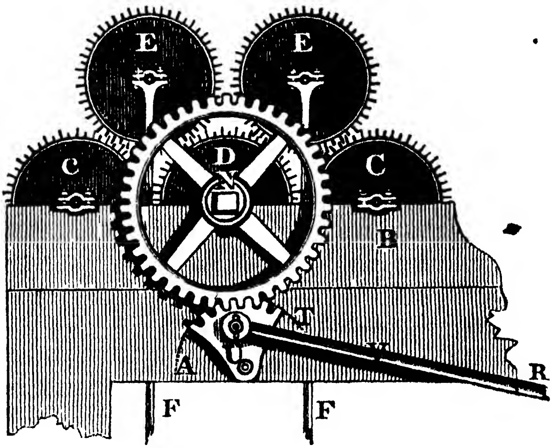


The annexed figure represents a side view of the breaking machine on a scale of three quarters of an inch to a foot. The framing, A, is of timber, which serves to support the five breaking cylinders marked C c D E E, turning on pivots. C D and c move in brass bearings, fixed upon the boards or supports B, on the two opposite sides of the machine, while E E

merely lay above and between C D and D *c*, and are drawn down to these by two rods, as seen at F F. The lower ends of these are joined by a connecting bar, and another rod proceeds downwards, its lower end being fixed by a double adjusting nut G, near the pin or fulcrum H, of the lever or presser, H I, which is loaded with a weight J.—There is a similar lever on each side of the machine, to bear down the four ends or pivots of the two rollers E E, and the ends of these levers nearest I, are united with a cross bar, by means of which one weight, J, acts on them both, and is made to press equally by an adjusting nut and screw, on each side, like G. K L is a lever placed under the machine, one end of which is attached to the weight J, in such manner that by pressing down its end L, J is raised, and all pressure is instantly prevented between the superior cylinders E E and those under them at C D *c*, for stopping the operation of the machine at any time. The breaking cylinders are about eighteen or twenty inches in length, and are made of beech or any hard wood, and are all similar to each other in dimensions, and in having breakers which act also as teeth, extending like projecting plates their whole length parallel to the axis. These breakers or teeth are formed of thin hoop iron let about half its width into saw cuts in the cylinders into which they are driven, and they are retained in their places by iron hoops put on to each end the cylinders; they are about half an inch asunder, their external edges are well rounded, so as not to cut the flax, and they are alternately long and short; the long or deep teeth projecting about three quarters of an inch from the cylinder, while the short ones are about half that length. In placing the lower breaking cylinders in their places care must be taken that they do not touch each other, since their teeth are only to connect through the medium of the two upper rollers which press upon them. The axis of the roller D is longe than the others, and extends on both sides beyond the frame, and upon each end of it is fixed a cast iron wheel, by which motion is to be given to this cylinder, and through this to all the others. Both the wheels are of the same diameter, but one is a ratchet wheel, as will be seen in the last figure, while

that on the opposite side is a spur or common toothed wheel, as will be seen in Fig. II. which represents such parts of the machine on the opposite side as are essential to its motion, and the same letters of reference are used in both figures to denote similar parts.

FIGURE II.



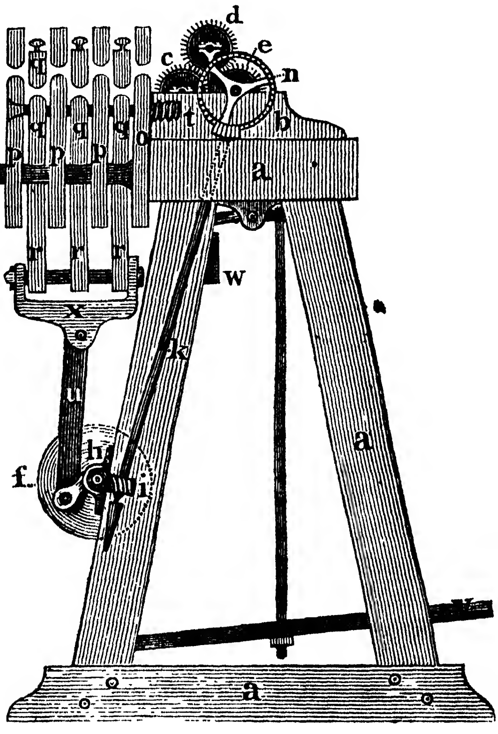
The first motion is given to this machine from the iron spindle O, Fig. I. which may be turned by a handle, or by a band and rigger, as at P. It may also be connected with a pair of spur wheels and a fly, as shewn in Fig. I. to assist its motion. On each end of the lower spindle, if two are used, there is a crank, as at Q, attached to a connecting rod V, the opposite end of which in Fig. I. is attached to a pall or lever turning on a centre S, so that when O, or O O, is turned, the end of this lever will describe a portion of a circle, shewn by the dotted line, T A, and will engage with the ratchet teeth of the wheel M, and carry it partly round; while on the other side of the machine, shewn in Fig. II. the connecting rod V passes from the crank of O to a toothed segment U, the teeth of which work into the teeth of the spur wheel N, fixed upon the opposite gudgeon of the breaking cylinder D. The connecting rod on this side of the machine must be so adjusted in length that in its motion outwards the end tooth of U, next

to A, must be withdrawn out of the teeth of the wheel N, but that when it moves in a contrary direction, or from T towards A, it must move completely in the teeth of the wheel, and not leave them, and of course N at this time is incapable of any other motion, but what the segment U also has.

The connecting rod Q V, in Fig. I. must also be so adjusted in length to the pall or gathering tooth S, as to make it continue to act upon its wheel M, for the space of one tooth of N in Fig. II. after the segment U has been withdrawn from its wheel N.; and thus although the motion of U would produce a backward and forward motion of its corresponding wheel N, and the breaking cylinder D, and consequently of all the other cylinders, yet by the after action of S upon M the roller D and its wheel N are made to advance gradually by the space of one tooth of N for every revolution of O; and thus a slow but regular progressive motion of the cylinders is obtained at the same time that the vibratory or oscillating motion is going on. The flax is fed or supplied by placing it in handfuls on the feeding trough Z, and pressing it gently between the rollers, C and E, and it is delivered out from between the rollers E and c, at the end of the machine next to L, in a sufficiently clean and divided state to enter the rubbing machine, which will be next described. The superiority of this machine over common fluted rollers needs no comment, since the distance between the teeth and the shake which is produced by the alternating motion of the cylinders exactly gives that action which is best suited to break off and disengage the bark and woody matter, which when dry, is quite brittle, and falls to the bottom of the machine. Once passing the rollers is in general sufficient for either flax or hemp stalks, but the work is rendered more perfect by a second passage through them, which does not at all injure the fibre.

The rubbing machine, which is to be used immediately after the above breaking process, was suggested to the inventor from the beneficial effect which he found produced on broken flax by rubbing it between the hands in the same manner that linen is rubbed while washing, and which not only cleanses it of the small fragments of wood and bark which

adhere to it, but likewise opens and subdivides the fibres, so as to make them produce the finest thread. The machine and operation are altogether new as applied to flax and hemp, and it is confidently hoped considerable benefit may arise from their use. The annexed figure represents a side view, or rather section of this machine, drawn on a scale of one inch to a foot.



In this, a is, the wooden frame for supporting the machine, b the bearers for the three rollers c d e, disposed as in the breaking machine, but in this case they are only for the purpose of drawing or leading the flax through the machine, (the breaking being presumed to have been already done by the last described, or any other process); they must be fluted or grooved, or may be made in the same manner as the breaking cylinders, but with the teeth of equal length, much shorter, and of a

finer gauge or pitch: f is a rigger or pulley to which a rapid circular motion is to be given; it is hung on a shaft or spindle turning in brass bearings, and fixed to the frame a; on the end h of this spindle is formed an endless screw or worm, which turns a small wheel i fixed upon the lower end of an iron spindle k turning in bearings, and leading by a bevil pinion at its upper end to the face wheel n, which is fixed on to one of the gudgeons of the fluted or toothed roller e, so that whenever the rigger f is turned, even with a rapid motion, a very slow motion will be communicated to the rollers c d e. The most essential part of this machine consists of the rubber boards o p q r, which are placed at the front of the machine, are seven in number in the print, but may be more or less, and are about an inch in thickness; they may be made of beech, oak, or any moderately hard wood. Their edges or sections can only be seen in this representation, but their length may be from eight inches to a foot or more. The board o is firmly fixed to the top of the framing a, and is without motion, while those marked p p p are supported upon the two strong cylindrical iron pins s, which are firmly screwed into the frame a, and pass through holes which fit them in the boards p p p, so that these last can be moved to a greater or less distance from each other, but are incapable of up and down motion. The intermediate boards q q q are so much shorter as to pass between the iron pins s and admit of an up and down motion between p p p; for this purpose they are all connected together by an iron link or staple x, fixed upon the top of the connecting rod u, the lower end of which works upon a crank in the middle of the first spindle upon which the rigger f is placed, so that in every revolution of f the moveable boards q q q are driven upwards and downwards between the more stationary boards p p p, and the one which is fixed at o. The whole of the boards are drawn towards o by means of a rod on each of their sides passing through p p p and o, and acted upon at t by weights or spiral wire springs, and the whole of the boards are perforated with a slit or mouth from four to six inches long (according to their width) and about a quarter of an inch wide, placed near their tops at an equal distance from the top of

each, and nicely rounded off on all its edges. The consequence will be that whenever the crank is in an horizontal situation, all these slits will coincide, but when the crank is down, as in the figure, the slits in q q q (which slits are seen only in section) will be below those in p p p and o, while when the crank is up they will be elevated above them; and thus it will easily be perceived that if flax, or any other flexible material, is passed through the slits in the boards when they do coincide, and then conducted between the toothed rollers, that while these draw it slowly on through the machine, the boards p p, q q, &c. by their rapid up and down motion, will effectually rub it, and cleanse it from any extraneous matter which may adhere to it, as well as open the fibres; and for the better regulation of this operation, v is a treadle or lever near the foot of the attendant, by pressing on which the weight w, which depresses the top roller d, will be raised, in consequence of which the rollers will cease to draw, although the rubbing still continues, so that its velocity in passing the machine may be correctly regulated at the will of the superintendant.

For the purpose of setting this machine to work in the first instance, and charging it with flax, the tops of all the rubbing boards are moveable, and made to separate through the slits which are made in them, for which purpose they are attached at one end by strong hinges, and are fixed down at the other by the thumb-screws which are shewn in the figure, or by any other sufficient fastenings. It will, however, only be necessary to open them on first setting them to work, since all future quantities of flax to be rubbed may be tailed on to that which is already in the machine, in the same manner as has been described in speaking of Mr. Lee's process. The flax is to be supplied by placing it on a perpetually revolving cloth, or feeding table, joined to the end s of the machine, and worked by connection to some of its wheels, but this is not shewn in the figure, as it forms no part of the invention, and is common in all flax and cotton manufactories.*

* For an account of the quantity of work these machines are capable of performing, and other particulars respecting them, see

The average crop which has been produced in England from sowing three bushels of flax or lint seed on an acre of land, is $2\frac{1}{2}$ tons of flax stem, which, when broken and prepared, yields from 10 to 13 cwt. of harle, or flax fit for hackling, and the boon or woody matter which falls through the machine, will yield from 90 to 100 bushels of chaff from the seed, and fit for provender for horses or cattle, and from 35 to 40 cwt. of chaff from the stem, making a valuable manure, while from 10 to 14 bushels of seed may, in almost all cases, be procured from the same quantity. The operation of hackling, which succeeds that of breaking, was here minutely described and shewn, and by this the average of 12 cwt. of harle, produced by an acre of land, becomes diminished down to about from 450 to 480 lbs. of fine long flax, fit for spinning the best materials, being but little more than $\frac{1}{11}$ of the gross produce: notwithstanding which, the value of the seed, the chaff, and the tow, which is the refuse of the hackling process, are said to amply compensate for this apparent loss.

Spinning is the operation which succeeds to hackling, and the advantages arising from this union, by twisting the fibres together, was detailed, as well as the mechanical action, by which strength and continuity of length are obtained by the lateral friction of one fibre against another. A brief sketch of the history of spinning, now of such vast importance to the British empire, was given, in which the respective merits of the distaff, the common spinning wheel, Antiss's and Barton's improved wheels, as rewarded by the Society of Arts, were contrasted with the extensive spinning machinery which exists in the north of England, as originally invented by Sir Richard Arkwright and Mr. Kay, and since improved so as to be applicable to almost every purpose.

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the Report of the Select Committee of the House of Commons on the subject, which for want of room we are obliged to defer until our next Number. Mr. Bundy has likewise invented a very ingenious machine for hackling flax, which is also included in his patent, but as it was not described on account of its not being completed when these Lectures were given, it cannot, with propriety, be described in this place, but will be noticed in a future Number.

Models of spinning machinery were exhibited and explained through their various processes of slivering, roving, and producing yarns, which is the general name applied to all single or primitive threads, since a thread, technically speaking, is always compound, or composed of more yarns than one. The yarns, when completed, are wound into skeins of 300 yards each in length, by means of counting reels, which strike upon a bell, or otherwise indicate when this quantity is complete, and such skeins are called *Leas.* From the number of leas which a pound of flax will produce, its denomination and value is computed. Thus yarn No. 10, or 10 lea yarn, is 10 times 300 yards, or 3000 yards from one pound of hackled flax; 40 lea yarn, or 12,000 yards from the pound, is said to be the finest produced in England by machine spinning, though by hand spinning the process has been carried as high as 120 leas to the pound. The average work of every spindle in a spinning mill, where thousands are usually in motion at once, is estimated at an average of 12 leas in the day, or 3600 yards; and in spinning the finest yarns the spindle is said to revolve 3000 times in a minute! Mr. Millington did not, however, vouch for this almost incredible velocity, not having had an opportunity of calculating the machinery.

The qualities of the tow, or refuse of flax and hemp, and the various operations performed upon it, were next enumerated and explained, among which was that of carding it, by machinery, so as to produce useful rovings for spinning inferior yarns; and several specimens of very fine and particularly strong white and brown paper were produced, manufactured entirely from the refuse, or shortest tow, by an entirely new adoption of that material, which seems to promise a great superiority over the rags at present made use of in paper making.

From the manufacture of flax and hemp Mr. Millington proceeded to that of woollen and cotton fabricks. The shearing, the sorting, and the cleansing of the wool were described, and the legislative acts mentioned by which this trade is protected in Great Britain. The growth, culture, and preparation of cotton were noticed in the same manner, and the

several modes by which these two substance are carded and spun into yarns, were contrasted together as they were explained; and this division of the subject was closed by a general account of the manner in which all fibrous materials are united into webs or cloths by the process of weaving, which was illustrated by models of looms, and their accompanying appartus for producing stripes, checks, tweels, tabbies, spots, and various devices; which was followed up by some practical observations on the manner of bleaching and dying in the piece, and a concise account of the processes of beetling, fulling, pressing, shearing, glazing, dressing, and calendering the various woven fabrics, and putting them into that finished state in which they appear for sale.

From the extent of our Report on the manufacture of Flax and Hemp, we regret that our limits will not permit us to give a more detailed account of the various other interesting subjects which were interwoven in this Course of Lectures. We must, therefore, close the present notice of it by observing, that Mr. Millington next proceeded to examine and explain those operations in which the mind of man is more concerned than his strength: under this head the art of Glass Blowing was treated. The construction of Locks for security, and the principles upon which those of Barron, Arkwright, and Bramah depend, were minutely detailed; and the history and practical art of printing with types, from stereotype plates, and from copper plates, was shewn, as well as the several varieties of Telegraphs which have, from time to time, been used, as being comprehended under the mechanical means of communicating ideas from one person to another.

Next to the power of man, animal strength would be resorted to as a prime mover, and accordingly the power of the horse, and the respective merits and advantages of the several carriages to which he is attached for transporting weights, or overcoming resistance, were next discussed at considerable length. The mechanical action of the horse alone, the construction of wheels and axletrees, and the nature of road resistance and friction, formed the subjects of four lectures, in which the principles of harnessing and attaching horses to their work, of

rendering carriages more safe; the great importance of springs; the utility of the patent propelling shafts, by which horses are attached behind as well as before their work; the principles of horse mills; the advantages of iron rail roads in commercial situations; the fallacy of attempting to construct carriages to go without horses, by the exertion of the rider, and many other particulars were explained and illustrated by working models, and diagrams

The motion which is obtained by water falling from an higher to a lower level, or running in currents, may be considered next in simplicity to that produced by animal exertion, and accordingly the power of water, as a mover of machinery, was next examined. This part of the subject was divided into four heads, the first considering water as a mere passive supporter to bodies floating on, or in it, and which were moved through it by external causes: secondly; where the bodies so floating, were operated upon by the current alone: thirdly; where water acts by its gravitation only in falling: and fourthly; where gravitation and impetus, or momentum, are acting conjointly. The first division naturally lead to an experimental inquiry into the resistance which floating bodies experience in passing through water; the best forms for diminishing that resistance, and the ratio in which it exists under given quantities of surface, presenting different angles to the line of motion; a subject of the highest importance in naval architecture; and this was succeeded by an account of the phenomena which occur in bodies floating with a stream. The artificial means of producing a continued level for this purpose, by means of locks and other contrivances, were here introduced, and after an account of the common and side pound lock, those of Sir William Congreve and Mr. Busby, were described. We lament, that our limits will not permit us to proceed to a particular description of these two latter ingenious and important inventions, that of the former gentleman, being so constructed, as to lose no water at all, and at the same time, to regulate the respective heights of the upper and lower levels in the most simple and perfect manner; while Mr. Busby's lock possesses some curious and valuable properties. Sir William Congreve obligingly lent a beautiful working model

of his lock on a large scale, for shewing the principles of its action.

The gravitating power of water was illustrated by a description of some of the most celebrated hydraulic engines on this construction, such as the Balance, and Sarjeant's machines, rewarded by the Society of Arts; the Hungarian machine; Boswell's machine; Bramah's press, and several others; while the joint action of water by its gravity and momentum, was demonstrated by an account of, and experiments upon the Water Ram, and a repetition of Smeaton's valuable experiments on undershot, breast, and overshot water wheels, made upon a newly constructed apparatus for that purpose, of the same dimensions as described by Smeaton, which, together with the Water Ram, the machine used for exemplifying the process of spinning, Doctor Barker's mill, and several other models and pieces of useful apparatus were made and obtained from the subscription fund which we noticed in our last Number as having been set on foot for augmenting and perfecting the collection of mechanical models and apparatus of the Royal Institution, and which we hope will be liberally followed up in the ensuing season. After detailing many useful practical particulars in the construction of water wheels and mills, and the most efficacious methods of supplying them with water, so as to act to the best advantage, Mr. Millington was under the necessity of breaking off this chain of subjects by the close of the season, but will take it up again in the ensuing season, when the remaining prime movers derived from the action of wind, elastic vapour, and destruction of equilibrium, will be treated in the same manner, as will appear by the particulars of the Lectures stated in another part of this Number.

ART. XVII. *On the Use of the Prussic (Hydrocyanic) Acid in the Treatment of certain Diseases of the Chest, and particularly in Pthysis Pulmonalis. By Dr.* MAGENDIE. *(Read at the Royal Academy of Sciences of Paris the 17th November, 1817, and communicated exclusively to the Editor of the Journal of the Royal Institution.)*

To the Editor of the Journal of Science and the Arts.

MY DEAR SIR,

THE very distinguished author of the subjoined memoir, well known for his zeal in promoting physiological science, has transmitted the original to me, immediately after its having been read before the Royal Academy of Sciences at Paris, with a request that I would translate it, and publish it exclusively in the Journal of the Royal Institution. The well merited reputation which this Journal has gained among the learned of the continental nations, for its candour, impartiality, and the originality of some of its valuable Papers, will explain this preference in my friend Dr. Magendie; and I feel happy in the opportunity of saying, that it is his intention and that of many other eminent characters in Paris and in Italy, with whom I have conversed on the subject, occasionally to favour the Journal with their original communications.

On the subject of the following pages I might descant a little, were it not superfluous to repeat what the author himself has so clearly stated. Its importance is too evident to need any recommendation. But you will perhaps allow me to say, that having been present at some of the experiments; conscious as I am, from actual examination during my residence in Paris, of the truth of many of the facts brought forward; and enjoying the pleasure of intimately knowing the author, to whose sagacity and talents I shall be happy on all occasions to do justice, I cannot hesitate in recommending

Dr. Magendie's paper to the earnest attention of all my medical brethren,

Yours truly,

8, *Saville Row,* A. B. GRANVILLE.
December, 1817.

PHYSIOLOGICAL experiments are of the utmost importance in the practice of medicine. It is by means of them, that substances used as medicines on mere hypothetical principles are justly rejected, and the really active remedies better known, or more beneficially employed, by varying their proportions and mode of administration. Another great advantage resulting from physiological experiments, is the discovery of new remedies, which the physician is enabled to make by their assistance, and by directing his attention to substances already known, but either neglected or seldom used, as well as to those preparations, which modern chemistry is daily bringing before us, and which, in the hand of an able and experienced practitioner, may become particularly useful to mankind.

It was on account of this firm persuasion, that I have ventured, at different periods, to call the attention of the Royal Academy of Sciences to the poisonous and medicinal qualities of the *Upas tieuté*, the *nux vomica*, the *supertartrate of antimony and potash*, and the *ipecacuanha.* The favourable reception which my researches have met with, have encouraged me to proceed farther, and, I shall have the honour this day of laying before the Academy, the result of my inquiries respecting the action of the prussic or hydrocyanic acid on the animal system, and the good effects which may be derived from it in the treatment of several diseases.

The prussic acid, discovered in 1780 by Scheele, was soon afterwards reckoned amongst the poisonous substances; an opinion which was confirmed by the experiments made, both in Germany and France, by Messrs. Coulon, Emmert, Robert, Orfila, &c.—From their experiments, and from some which

are peculiarly my own, it results; 1st, that tho prussic acid, whether liquid or in the state of vapour, is injurious to the life of all animals, and in many cases, to that of vegetables; 2nd, that death produced by this acid is much more instantaneous, from the circulation becoming more rapid, and the lungs more distended; 3rd, that it acts on warm blooded animals by destroying their sensibility and the contractility of the voluntary muscles; and would act in a similar manner on man, where the dose given is greater than what will be hereafter mentioned.

It cannot be denied, therefore, that the prussic acid is a very active poison; and yet all the experiments I have just now alluded to, have been made with the prussic acid of Scheele, which contained a very considerable quantity of water, and was consequently very weak. From this circumstance it will be easy to conceive, that the effects of the *pure* acid, prepared according to Gay Lussac's directions, must need be much more energetic. Its activity, indeed, is really frightful, even to those who are accustomed to witness the effects of poison. Of this the Academy shall judge by the following facts.

Experiment 1. The extremity of a glass tube which had been previously dipped into a phial containing some pure prussic acid, was immediately plunged into the throat of a strong dog. The tube had scarcely come in contact with the tongue, than the animal made two or three long and rapid inspirations, and fell dead. No method we could devise enabled us, afterwards, to trace the smallest sign of sensibility in the muscular organs of this animal after death.

Experiment 2. An *atom* of the acid was applied to the eye of another strong dog; the effects were as sudden and as fatal as in the preceding experiment.

Experiment 3. A drop of the acid diluted with four drops of alcohol, were injected into the jugular vein of a third dog. The animal fell dead, that instant, as if struck by *a cannon shot or by lightning.*

In short, the pure prussic acid, prepared according to M. Gay Lussac, is without doubt, of all the known poisons, the

most active and the most promptly mortal. Its deleterious and powerful influence permits us to believe, what the historians have related, of the criminal talent of Laucustus; and render the accounts of those extraordinary and sudden cases of poisoning, so frequent in the annals of Italy, less marvellous and incredible.

I must not omit to say, likewise, for the sake of those who should feel disposed to make experiments with this substance, that the utmost caution is necessary; as it is impossible to breathe its vapour without feeling the most dangerous effects. Owing to some neglect on our part, in this respect, we have at one time experienced the most excruciating pain in the chest, accompanied by a feeling of insupportable oppression, which lasted some hours.

It might appear from all this that the pure prussic acid in the hands of one intent on murder, would become the instrument of crime, without fear of detection; but the public may make themselves easy on that score. More nicety of manipulation, and dexterity in the operations of chemistry is required to procure this acid, than falls to the lot of common people; and even when properly prepared, it is almost impossible to preserve it in its state of purity, as I have ascertained by direct experiment. It is spontaneously decomposed at the ordinary temperature of the atmosphere, and then loses, in a short time, all its obnoxious qualities. Besides, though the prussic acid produces death, without any visible alteration of the animal organs, it is easy to detect a case of poisoning by it: for the body will exhale, during several days, a strong smell of bitter almonds.

Poisonous as it is, there is no doubt, but that the prussic acid may, when properly diluted with water, be used as a medicine with safety. We know from the experiments which Mons. Coulon made on himself, that it may be given to the dose of sixty drops without producing any very serious inconvenience. Besides the pretty frequent use made in medicine, of the laurel water, in which the prussic acid enters, as a component principle, proves that it may be introduced into the stomach when properly diluted. Nothing therefore, shews

any impropriety in its use as a remedy; a circumstance which has already induced some French and Italian physicians to give it in various disorders. If their success has not been equal to their expectations, it is because they did not seem sufficiently aware of its mode of action on the animal economy: and without this knowledge it is impossible to make a right use of any new remedy whatever.

In studying the phenomena of poisoning by prussic acid, I have often observed, that animals, in which no trace of sensibility, or muscular contractility could be found, would often continue to breathe for several hours, freely, while their circulation, though much accelerated, remained apparently unaltered. These animals indeed might have been said to be dead with regard to their external functions, yet still enjoying life, through their nutritive faculties.

This property of extinguishing the general sensibility without any ostensible injury to the respiration and circulation, the two principal functions of life, induced me first to believe that the prussic acid might be advantageously used in cases where the disease seemed to owe its origin to a vicious augmentation of sensibility. From that moment I determined to use it whenever any such case should offer itself to my attention.

About three years ago I was consulted in behalf of a young lady aged 27, who for the space of eighteen months, had been distressed by a dry short cough, which became stronger in the evening and in the morning. Alarmed at these symptoms, which seemed to indicate an affection of the lungs, her friends took the advice of several of the most distinguished medical practitioners of the Capital, who all prescribed the usual remedies in such cases, but without success. I ordered her six drops of Scheele's prussic acid, prepared by Pelletier, diluted with three ounces of a vegetable infusion; to be taken by spoonfuls every two hours. The following day the cough had considerably diminished, and it disappeared entirely on the fourth.

The cough however having made once more its appearance six months afterwards, I repeated the same remedy with an equal success.

Since then I have had repeated opportunities, but chiefly with young ladies, to employ the prussic acid in cases of nervous and chronic coughs; and have always obtained the greatest success, without having observed any inconvenience from it. In no case have I gone beyond the dose of *ten* drops taken at intervals during twenty four hours, and diluting it with several ounces of some fluid vehicle.

Very lately I have succeeded in calming by this same means a convulsive cough, with which an elderly lady of a nervous temperament had been greatly affected, and which for six days previous to my seeing her, had come on by alarming fits, depriving her of all rest. I was so much the more willing to adopt in this case the use of prussic acid, as the patient could take neither opium nor any preparation of poppies without being grievously incommoded.

After thus having ascertained the efficacy of the prussic acid in the treatment of dry convulsive cough, I thought it was indispensable for me to inquire whether the same means might not be employed with success to combat the cough and other symptoms which overpower the unhappy consumptive—and whether it would not influence, or even suspend the progress of pulmonary consuption.

The result of my trials has been favourable with regard to the first of these conjectures; and on fifteen persons, affected with pthysis, who had been placed under my care for the last three years, I have constantly found that the use of the prussic acid, given in small but repeated doses, diminished the frequency of the cough, moderated, and rendered more easy the expectoration, and lastly, procured the patients some sleep at night without any colliquative sweats. Those who are accustomed to follow the march and progress of pthysis, and witness the sufferings without number, by which individuals attacked by this terrible malady, are overpowered, will easily appreciate the real benefit of this success.

Since the beginning of the month of August last to this day (November) I have had many opportunities of studying the effects of prussic acid on a great number of pthysical patients at the hospital of *la Charité*, Mons. Lerminier, physician to that

hospital, in which such diseases are very frequent, has, at my request, agreed to administer the prussic acid in about twenty cases, at the dose of four drops properly diluted with water.

The greater number have shewn evident signs of amelioration, and some seem much better at this moment. The cough is considerably diminished. The expectoration has become easy, and sleep came to shorten their sufferings. These improvements became more evident, where the disease was in an incipient state; a circumstance which is not difficult to explain, when it is considered, that the lungs are in a state of disorganization, in the second, and above all, in the third stage of consumption.

Yet as I wish to state merely, in this place, the *exact* effects of the prussic acid, I must avow that amongst the patients of *la Charité*, who have used it, some, whose disease was near its end, did not derive any very sensible benefit from it; and that in two instances, in which the patients had taken the acid at too short intervals, experienced some headache, and a kind of vertigo which lasted some seconds. In a third case it was feared that the acid had proved injurious.

A young man aged 29 was admitted into the hospital towards the end of September last with all the symptoms of a confirmed pthysis.* The acid was given in the dose of six drops only. The cough diminished the second day; but the oppression increased; the third day it became suffocating, though the acid had been discontinued the preceding day; and the patient fell into a sort of insensibility which terminated in a few hours in death. This could not have failed to raise some suspicions against the remedy, if the examination *post mortem* had not clearly shewn, that the fatal termination of the malady, was owing to an immense quantity of serous fluid found in the left side of the thorax; the heart

* Contrary to the established practice of Mons. Lerminier, the chest was not explored by means of percussion, as generally done with all the patients who enter at *la Charité*. This prevented the discovery of an old inflammation of the pleura which affected the left side of the chest.

being thrown to the right, and touching the ribs of that side. Neither the stomach nor the body exhaled any prussic smell. The disease in this case was in its second stage; but it was evidently not the principal disease by which the patient was affected, a circumstance which will account for the absence of all sort of beneficial results from the prussic acid.

In my private practice I never observed any bad effect to result from the action of the prussic acid given as I directed, which may be accounted for by considering the great care and attention which a patient in the bosom of his family receives at every moment; the case being necessarily different in regard to patients in even the best regulated hospitals.

From all that precedes I think I am warranted in concluding, that the prussic acid, given in small doses, mixed with a certain quantity of water, may be advantageously employed as a palliative treatment of consumption, with a view of calming the cough, facilitating the expectoration, and procuring sleep; and that as such it must be considered as the first among the substances usually employed for similar purposes; as it does not seem to excite, like the opiates, any colliquative sweat.

It still remains to inquire, whether by the assistance of the prussic acid and of its marvellous activity, we might not hope to render the march of pthysis more slow and even to cure it. But these questions, in themselves so important on account of the too fatal prevalence of the malady, cannot be decided by a small number of facts and experiments. They ought, on the contrary to be multiplied as much as possible, taking at the same time into consideration all the circumstances which might influence the results; and divesting ourselves of all sort of prejudice.

I am continuing my experiments on this subject, conjointly with M. Lerminier, at the hospital of *la Charité*, where, from twenty to thirty consumptive patients are habitually received; and I am in hopes to lay before the Academy, in the course of the next year, some facts worthy of their attention.

Some may consider it as a mark of temerity in me to sup-

pose that pthysis may be cured, when so many very eminent authors look upon it as absolutely mortal. But admitting that pthysis be incurable, with reference to all the substances hitherto employed, and the experiments hitherto made for that purpose in the true spirit of truth and investigation, the same mode of reasoning cannot hold good with regard to new substances, remarkable for the energy of their action on the animal economy: besides, ought not the physician to direct his attention to the cure of such diseases as *pthysis, cancer, &c.* in preference to merely varying the treatment of such diseases as, from peculiar circumstances and their nature, terminate always happily, whatever be the remedy suggested by fashion or caprice?

I shall now relate two cases in which there is reason to presume that pthysis was checked in its progress by the use of prussic acid.

CASE I.

A lady from Lyons, now residing in Paris, of a constitution eminently bilious, after having experienced several misfortunes, was in 1814, attacked by all the symptoms which characterise pthysis in its first stage. Circumstances not allowing her to attend to her health, she neglected it, until within the first months of 1815, when the disease having made great progress, she consulted me: I found her labouring under all the symptoms of the second stage of tuberculous consumption, with a cough returning incessantly, and a slow continued fever preying upon her and undermining her existence. The prussic acid was recommended, and taken at the dose of from six to ten drops in twenty four hours, diluted. This acid had been prepared by Mons. Planche, by a new process which I shall hereafter describe. The remedy was continued for about two months. From the first day the cough diminished, the patient slept, and without pushing the dose higher than ten drops in the 24 hours, all the symptoms of the disease disappeared, the breathing became natural, the cough, expectoration, and sweats ceased. In short, the lady was perfectly cured, and has never since experienced any symptoms, which indicate the

least disposition to a relapse. Her lungs, only, have become very sensible to the influence of atmospherical variations.

Must we conclude from this fact, that a consumption in its second stage has been cured by the prussic acid? I am far from thinking so; for I know with how much reserve we ought to draw any general and positive conclusion. Yet such as it is, and with all the importance attached to it, I submit the case to the practitioners, who take an interest in the progress of science.

CASE II.

An English lady aged 28, tall, and of a weak constitution, with a chest transversely ample, but narrow, was frequently subject to colds from her infancy. Last year, while crossing over from France to England, she was attacked by an inflammation of the lungs, with acute pain of the left side of the thorax, and spitting of blood. Bleeding, blisters, and all the means usually adopted in such cases, were had recourse to and she got well; but she continued to suffer from a short dry cough, of no great intensity during the day, but which became greatly exasperated in the night. Several means were employed in England to check it; with no success. Believing that the climate of France might prove more beneficial to her health she returned to Paris about four months ago. In spite of the fineness of the season, and residence in the country, the cough made considerable progress; she became uneasy and alarmed; and I was sent for about the middle of September last; when after a mature examination of all the preceding circumstances, and her actual state, I did not hesitate in considering her as labouring under the first stage of pulmonary consumption. I prescribed the prussic acid, prepared by Mr. Planche, in the dose of 8 drops in three ounces of water in 24 hours. She has continued it ever since, and is at this day taking it. Her cough has nearly vanished altogether; she has gained considerable *embon point;* and she considers herself at this moment as quite recovered.

Far be it from me to suppose that this is another instance of

pulmonary consumption cured by the prussic acid. Yet it must be confessed that if examples like the two preceding ones, were to become numerous, nothing could then prevent us from hoping, that we may at last have found a substance capable of arresting the progress of one of the most desolating maladies by which humanity is afflicted.

I shall conclude with a few words on the mode of preparing the prussic acid. If it be prepared in the way directed by Scheele, we run the chance of obtaining it at various degrees of concentration—a circumstance which ought by all means to be avoided. M. Planche, one of the most distinguished *pharmaciens* of Paris, follows a method which renders its preparation less uncertain. Instead of drawing one-fourth of the produce by distillation, as the illustrious Swedish chemist first suggested, he stops the operation, as soon as $\frac{1}{6}$ of the produce has passed into the receiver. He next rectifies the liquid thus obtained by means of a gentle fire, over $\frac{1}{100}$ of carbonate of lime, and draws off $\frac{1}{2}$ only of the whole by distillation.

Thus prepared the prussic acid is certainly far from possessing the activity of that prepared by Gay Lussac; but it has more energy than that of Scheele, and above all, it has an *invariable* energy; since, according to M. Planche, it is always at the same degree of concentration. It also affords one other advantage, that of being susceptible of preservation, if kept in a cool place, equally removed from the influence of air and light.

I have also employed in many cases the acid prepared according to Scheele's method, and have not been struck with any difference in its action, (such as the theory of chemical doctrine seems to suggest) whenever I have taken care to get it at the houses of our best chemists.

The observations in this Paper are,

1st. That the pure prussic acid is a substance eminently deleterious and altogether unfit to be used as a medicine.

2ndly. That the prussic acid diluted with water is beneficial in cases of chronic and nervous cough.

3dly. That this same acid may be useful in the palliative

treatment of pthysis, by diminishing the intensity and frequency of the cough, and in procuring sleep, &c.

4thly. That there is reason to hope that this same substance may become advantageous, as a curative treatment of pulmonary pthysis, particularly when in an incipient state.

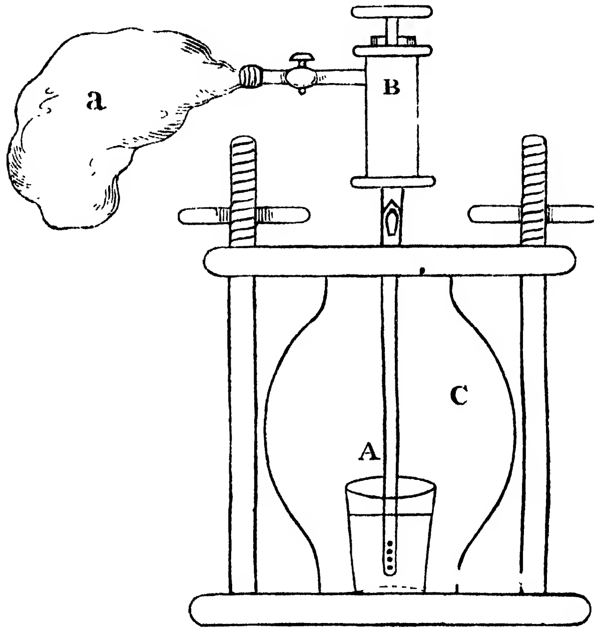
Art. XVIII. *Description of an improved Apparatus for the Manufacture of Soda Water (with a Plate); by* William Hasledine Pepys, *Esq. F. R.S.*

To the Editor.

We are indebted to chemistry for our knowledge of the composition of mineral waters, and to the same science we owe all their artificial imitations. The pleasing and brisk flavour that water acquires by combination with carbonic acid, was very early noticed by Hales and Priestley, but it was from the glass apparatus of Nooth that this compound first obtained its celebrity with the public. In the year 1798, I assisted my friend Mr. Desvignes, in a number of experiments on the impregnation of water with this gas, and that same year he gave an account of his new apparatus, with a plate, in the Philosophical Magazine; but the slow operation of these methods, and the much higher state of impregnation of the water sold by Mr. Shweppe, whose process was then a secret, induced the chemist to call in the aid of mechanism, and the first apparatus in which the condensing pumps were used openly, I saw at an apothecary's in the city, who did not claim the original invention, as it had been suggested to him by several of his chemical friends. About the year 1800 I had a condensing apparatus constructed for my own use, in which I considered I had made several advantageous additions in point of the purity of the water and higher impregnation; this I some years afterwards parted with to my friends Allen and Howard, and the model not being very large, they constructed one upon a more extensive scale, with considerable further improvements.

In a paper I read before the Askesian Society in 1802, on the gasses, accompanied by experiments, among the various methods of impregnating fluids with the gases, I shewed them,

by means of the common glass condensing machine, that a tumbler of water might be charged with carbonic acid. In the annexed figure, I have given the plan which I then used.



a. Bladder of carbonic acid gas.

B. Condenser.

C. Glass to the condenser containing the water to be impregnated in a tumbler; the tube A was of silver.

Upon considering this method, it suggested itself to me that any decanter or glass vessel of the ordinary strength might be enclosed within a metallic one formed of two parts flaunched together, and of such strength as to bear any pressure that might be wanted, for the impregnation of fluids with gases, without any liability of breaking the glass, or any danger of the contact of the fluid with the metallic parts of the apparatus, as by leaving a space between the glass, and metal vessel, to which the condensed gas might have equal access, no rupture of the glass could take place, being under exactly the same pressure on all sides.

To those who are aware of the powerful effects of solutions of carbonic acid, upon the oxides of metals, by which means compounds of copper, zinc, and lead, may be introduced, with a pleasant and agreeable beverage, their taste being covered by the briskness of the acid gas, this will be deemed an useful addition to our chemical apparatus, and from the quantity of soda water now consumed will, I trust, appear also of very general importance.

Considering that it might be worthy of a place in your valuable Journal, I have sent a drawing of an apparatus that I have lately had constructed on this principle. As I do not recollect having seen any plate or drawing of the usual methods of condensing, and procuring the carbonic acid gas, I have accompanied it with them also, which you will alter or withdraw as you may think most proper. See plate IX.

WILLIAM HASLEDINE PEPYS.

Description of the Plate.

A. The gasometer in which the carbonic acid gas is generated, from chalk and dilute sulphuric acid.

B. A small cistern containing some water to arrest any sulphuric acid that might be contained in the gas.

C. The condenser worked by a handle and fly wheel. The valves at *a* and *b* shew the direction in which the gas is propelled.

D. The improved vessels in which the fluid is to be impregnated with the gas. *a* shews the interior vessel of glass. *b* the exterior vessel of strong copper flaunched and screwed together at *c*.

d d d are small pieces of cork upon which the glass vessel rests and is kept steady within the copper one.

e is a safety valve.

f is a cone and screw which serves the purpose of a cock.

g shews the position of a bottle with the lever and support that are used in the decantation.

The tube that enters the fluid, and all the passages through which it passes in decantation, are lined with metal not acted upon by carbonic acid.

Article XIX. *On the Sulphuret of Phosphorus; by M. Faraday, Chem. Assistant in the Royal Institution.*

Sulphur and phosphorus heated together in a tube combine, frequently with explosion, and a compound is formed which decomposes water at common temperatures giving off sulphuretted hydrogen; and acids, as the phosphoric, phosphorous, and sometimes sulphuric remain in the water. These compounds are generally impure from the presence of oxide of phosphorus and other matters. They are more fusible than either sulphur or phosphorus, sometimes not becoming solid at common temperatures.

If one of these fluid compounds be shaken with solution of ammonia, and left for a few hours in it, all the impurities disappear; the reddish or brown colour is removed, and a pure compound of a light-yellow colour, semitransparent, and of greater fluidity, is obtained.

If the ammonia be removed and the substance be transferred into water, it does not perceptibly act upon it in several weeks. If phosphorus and sulphur be added alternately to a portion of it, any quantity of the two substances may be combined, and in any proportion; so that near approximations may in this way be gained to the proportions of the elements in compounds possessing peculiar properties.

A compound prepared in this way, and which I believe contained about 5 of sulphur to 7 of phosphorus, did not become solid at a temperature of 20° Fahrenheit, and was very fluid at 32°. On remaining for some weeks in a bottle with water, it deposited crystals of pure sulphur, and a compound remained that was not so fusible as the former, but on remaining in an atmosphere of 38° or 40° for twelve or fourteen hours, became a crystalline mass. This is probably a definite compound of sulphur and phosphorus. I endeavoured to analyse it by converting the two substances into acids, and then estimating the quantity of sulphate and phosphate of barytes produced by precipitation with barytic salts, I obtained 29.1 grains of dry sulphate of barytes, but the phosphate was partly lost in conse-

quence of its solubility in nitrates. The sulphate of barytes indicates nearly 4 of sulphur, and as 12 was the quantity of the compound acted on, it gives the phosphorus as 8. A compound made by adding 4 of sulphur to 8 of phosphorus, in the way before described, had very nearly the same appearance and properties. These proportions must, however, be considered as approximations only; but it is worthy of notice that the fluid compound of 5 sulphur and 7 phosphorus is nearly as 1 proportion of the first to 2 of the latter, and the compound of 4 and 8 as 1 proportion to 3; the number of sulphur being 15, that of phosphorus 10.

The purified compounds of sulphur and phosphorus do not act on water at common temperatures, nor rapidly even at their boiling point. It is likely therefore that the action which is observed when the compound formed by heat in a tube is placed in contact with water, and which is very brisk, results from the presence of some combination of oxygen and phosphorus on the water. That the phosphorus takes the oxygen and not the sulphur, is evident from the quantity of phosphorus and phosphoric acids afterwards found in the solution, and the sulphuretted hydrogen given off.

Art. XX. *Proceedings of the Royal Society of London.*

In consequence of the lamented death of H. R. H. the Princess Charlotte of Wales, the Society did not resume its sittings, for the transaction of ordinary business, until Thursday, November 20th, on which occasion, the Croonian Lecture was read by Sir Everard Home, containing an account of the changes which the blood undergoes in the act of coagulation.

Aided by the microscopic abilities of Mr. Bauer, Sir Everard estimates the bulk of the globules in human blood; of which, when enveloped in their colouring matter, 2,560,000 would be required to cover a square inch. During the blood's coagulation, these globules were observed to arrange them-

selves in lines, which struck the author as much resembling a single muscular fibre, and on unravelling a muscle, a very similar appearance was obtained as its ultimate fibre, which he therefore considers as originating in this arrangement of the blood's globules.

Another curious fact observed was, that the blood in the act of coagulation, assumed a tubular texture, forming a beautiful net-work of anastomosing canals. This is referred to a peculiar extrication of air during the coagulation, and leaves no difficulty in accounting for the way in which it afterwards becomes vascular. Very beautiful drawings, from the pencil of Mr. Bauer, accompanied this curious paper, which were exhibited to the Society.

Nov. 27. Mr. Seppings read a paper on the great strength given to ships of war, by the application of diagonal braces.

Several instances are here adduced, of the great advantage derived from the above plan of ship-building, of which a detailed account is printed in the Phil. Trans. for 1814. The author also vindicates his claims to originality, as the first who applied this mode of construction.

Monday, Dec. 1. The Society met for the anniversary business of electing officers. The Right Hon. Sir Joseph Banks, Bart. G. C. B. was unanimously re-elected President; W. T. Brande, and Taylor Combe, Esquires, Secretaries,—Dr. Thomas Young, Foreign Secretary, and S. Lysons, Esq. Treasurer for the year ensuing. The President addressed a learned and eloquent speech to Captain Kater, upon the subject of an universal standard measure, and presented him with the gold medal called Sir Godfrey Copley's medal, for his communication to the Society, concerning the length of the seconds pendulum.

Dec. 11. Captain Burney's Memoir on the Geography of the North Eastern part of Asia, was read. After taking a general view of the geographical discoveries of different travellers in those parts, from Deschnew down to Cooke, whom Captain Burney accompanied, our author records it as his opinion, that Asia and America are parts of one and the same

Continent, and that consequently there is no north-west passage, as it is usually called.

Dec. 18. A paper on vegetable colouring matter was read, by James Smithson, Esq.

It consisted of scattered remarks on turnesole, on the colouring principle of the violet, of sugar-loaf paper, of the mulberry, the corn poppy, and sap green.

At the same meeting, a letter was read from Dr. John Davy, at Ceylon, to his brother Sir Humphry, giving an account of Adam's Peak, and of its sacred summit, upon which is the impression of the foot of Buddow, which Dr. Davy regards as in a great measure artificial, and the work of priestcraft.

This letter contains an interesting account of certain religious ceremonies of the natives. Gneiss, quartz, felspar, and garnets, are the chief constituents of the mountain. Its height, above the level of the sea, is about 6400 feet.

In consequence of the ensuing vacation, the Society adjourned to the second Thursday in January.

Art. XXI. *Proceedings of the Royal Academy of Sciences at Paris.*

Sept. 8, 1817.—A letter from Scarpa thanked the class for his nomination as a foreign associate.

A medal of La Grange was presented by M. Donadio.

A letter was received from Mr. Joseph Sabine, announcing that the Transactions of the Horticultural Society of London would be forwarded to the Academy.

A letter from the Minister of the Interior announced the King's approval of M. Piazzi as a foreign associate.

M. Rozier Coze presented his researches on chlorine and hydrochloric acid.

Thenard and Gay Lussac were appointed commissioners.

M. Lemoin informed the meeting that he had placed a concave mirror on the turret in the *Jardin Baujon*, the effect of which might be seen from the dome of the Institute.

M. Lamark read a report on Mr. Robert Brown's memoir relative to the natural families of plants called *Compositæ.*

M. Baudois read a report on a memoir, entitled, *de Orchidæis Europæis*, &c. *Auctore, L. C. Richard.*

Sept. 19. After various presents had been received M. Moreau de Jonnes read a memoir, entitled, *Exploration Géologique et Minéralogique des Montagnes volcaniques du Vauclin dans l'Isle de Martinique*, &c.

M. de Souza presented his magnificent edition of *Camoens.*

Reports were presented by several commissioners on works which they had examined.

Sept. 29. Dr. Wilson Philip's work on Vital functions was received, and M. Humboldt was desired to examine and report upon it.

M. Arago presented a letter from M. Dupin on the Aurora Borealis observed at Glasgow on the 19th of September.

M. Lapostolla of Amiens sent an account of his *Paratonnerres* and *Paragrèles*, inventions for preserving the harvest during storms.

Oct. 6. Several presents were received.

M. Cocqbert Montbret read an account of Krusenstern voyage.

M. Henri gave an account of a mass of oxide of iron containing the native metal, found near Florac (*dep. de la Lozère).*

Oct. 13. M. Babinet sent a memoir, *Sur le Degrè de Precision de la Formule donnée par M. Laplace sur la Déviation d'un Corps qui tombe d'une grande hauteur.*

M. Mollard and Ampere read a report on Lord Cochrane's lamps; but the Academy being informed that the Minister of Marine was making experiments upon them, desired the commissioners to assist him, and suspended their decision till his report was received.

Oct. 20. M. Opoix read a paper, *Sur la Manière de Conserver la Beurre frais.*

Oct. 27. M. Girard read a paper, *Sur l'Ecoulement de l'Ether, et de quelques autres Fluides, par des Tubes capillaires de Verre.*

M. Bosc, in the name of the commission, gave a report on M. Guillet's memoir, *Sur l'Arrondissement de Maremmes.* We insert from this the following particulars concerning the oyster fishery.

"On pêche les huîtres sur les côtes voisines, principalement vis-à-vis Oléron et l'île d'Aix, et on préfère, pour les faire parquer, celles qui sont petites et rondes. On appelle *claires*, dans le pays, les parcs destinés à faire verder les huîtres. Ce sont des espaces, le plus ordinairement de 600 à 800 mètres carrés, choisis sur la plage, des deux côtés de la rivière, et entourés d'une levée assez basse pour que les marées des syzygies la surmontent.

"Le talent de celui qui a soin des claires consiste, 1° à n'y mettre que la quantité d'huîtres qui peuvent y prospérer; 2° à les transporter, tous les ans, dans une autre claire qui n'en ait pas nourri l'année précédente; 3° à augmenter l'eau pendant l'hiver pour empêcher l'effet des grandes gelées qui font périr les huîtres; 4° à s'opposer à l'entrée des eaux des pluies ou de la rivière, qui sont également pernicieuses. Les huîtres ne sont marchandes qu'après trois ans de séjour dans les claires. Un plus long temps les rend plus grasses et plus délicates."

November 3. M. Hachette presented a memoir on high pressure steam engines.

M. Hazard read a report on M. Girard's paper, *Sur le Vomissement des Animaux herbivores et carnivores.*

M. Cauchy read a report on the *Flotteur*, or *Hydrobascule* of M. Capron.

Nov. 10. After various presents had been announced, M. Geoffroy St. Hilaire read a memoir, *Sur les os intérieures de la poitrine dans les Animaux vertébres.*

Nov. 17. M. Cloquet presented his translation of a practice of physic, by Dr. Thomas of Salisbury.

M. Moreau de Jonnés presented his remarks on the yellow fever of the Antilles.

M. Fourrier read a memoir *Sur le Température des Habitations*, &c.

M. Magendie read his paper, *Sur l'Emploi de l'Acide prusique dans le traitement de plusieurs maladies de poitrine*, &c.

[This paper he has favoured us with for insertion in this Journal. See page 386.]

Nov. 24. The Marshal Duke of Ragusa distributed copies of his Eloge on the Count d'Abville, read to the Chamber of Peers.

Several presents were received.

M. Fresnel read a memoir, *Sur les Modifications la Réflexion imprime à la lumière polarisée.*

The following list for the election of a corresponding member in the section of geometry was given in by M. Laplace.

M. Krampf, of Strasburgh.
M. Ivory, of England.
M. Plana, of Turin.
M. de Gorgone, of Montpellier.

Dec. 1. Several presents were, as usual, announced.

The Academy proceeded to appoint a correspondent in the Zoologic section, when the votes were as follows:

For M. Lamouroux	35
M. Schneider,	7
M. Rudolfi	3

M. Lamouroux therefore was declared duly elected, and M. Krampf having 44 votes, was also announced as the corresponding member in the geometric section.

Art. XXII. *Miscellanea.*

I. *On the Preservation of Meat by means of Charcoal.*

The antiseptic power of charcoal has long been known; the domestic use of it to remove or to disguise a slight taint of meat, which has been overkept, is familiar: as is the employment of it to subdue the stench of animal corruption in other circumstances. Trials had been likewise made of it for preserving raw meat for a long time, and preventing instead of

merely remedying the decay; but not with complete success, nor satisfactory results. I was therefore desirous of instituting trials of its efficacy, aided by other means for obviating the usual concurrent causes of putrescence: which appear to be moisture, warmth, and the access of atmospheric air.

With this view I procured some vessels to be made of tin, which may be shortly described as canisters, to which a sliding lid is adapted. Into these vessels fumes of charcoal were introduced to expel the air, and substitute for it carbonic acid. They were then filled with slices of raw meat between layers of dry charcoal powder, and carefully closed, luting the lid, and then covering the whole with bladder. In this state the tin vessels were placed in a wine cellar, where they remained for more than eight months, from the beginning of April to the present month (December).

Four of these vessels were opened on the 6th and the remainder on the 8th December. The meat was found perfectly sound, firm, and sweet; except two small pieces which were soft. In all the rest, including three sorts of meat, the fat and the lean were alike good: and, on rubbing or scraping off the charcoal, the raw meat had precisely the appearance which it has when fresh from the shambles Some of the pieces were dressed and tasted; and were pronounced to be entirely sound. A few were kept, after being taken out of the charceal, and did not become tainted until after six days.

The charcoal had imbibed a smell not unlike that of dried meat; but not materially offensive. The meat itself, was entirely free from that smell.

It is my intention to repeat and vary the experiment, chiefly with a view to ascertain whether any considerable changes of temperature can be rendered consistent with the preservation of raw meat by this method; observing the other precautions. It is plain however, that independently of still greater usefulness which would attend so desirable a result, the mode followed to the extent of the present successful trial cannot but be attended with much practical utility. It is both simple and cheap.

Upon this account, and considering the time requisite to

make progress in experiments where results are not obtained until after several moths, I have not judged it necessary to defer the communication of the success which has attended a first trial.

15*th December*, 1817. H. T. C.

II. *On the Tourmalin and Apatite of Devonshire ; from Mr.* Mawe.

The spot where these beautiful minerals have lately been found is so little known, that I trust the following short notice will find a place in your Journal, and please your mineralogical readers. The tourmalin and apatite accompanied by quartz with jasper and ochrey matter, formed beautiful groups upon granite. The crystals of the two former were such as to astonish the oldest mineralogists, both on account of their magnitude and perfection I have in my possession some large specimens containing a surface of about a hundred square inches, completely covered with perfect six-sided prisms of apatite, many of which are more than an inch in diameter; and tourmalin in crystals of from two to four inches in diameter. These fine specimens remained long unnoticed and were much undervalued. The owner asked a gentleman a few shillings for one of them, who, after selecting as many as he could well carry, replied, " Farmer, they are neither gold nor silver," and gave him a shilling.

They are found in a granite rock, which protruding into a wheat field, arrested the progress of the plough. A person agreed to remove it, by blasting, for a trifling sum, and after some time was pleased with its " nubs of shining black." Mr. Ellis then employed it to build a wall on his farm, and disliking its " magpie" appearance, *had it whitewashed*; at last a specimen fell into the hands of Mr. Johnson of Exeter, who shewed it to Mr. Loscombe of Exmouth, a gentleman well known for his zeal as a mineralogist; he was induced to visit the spot, and forwarded me a specimen, which I sent to Mr. Sowerby to embellish his excellent work on English minerals: he also wrote to me as follows:

" I have sent you as many of the tourmaline specimens as

I could, at present, procure, also some fine red felspar; one specimen has an opalescent vein of quartz running through it, coloured like cairn gorum; there are also crystals of felspar and adulare. Sowerby has published schorl somewhat similar, and remarks how curiously the fibres penetrate into the quartz. In these you see such fibres, but not in contact with any other substance; it must therefore depend on a different law from what he supposes.

"They are found in a small excavation, not above four feet below the surface, which is between rocks of Devonshire granite, such as the pavement of Westminster Bridge. They appear to fill a small cavity, which I should think will not be very extensive. It principally lies at the north and south ends; and not ten yards distant is a vein of micacious iron, taking an east and west direction. Penwood Hill, three miles distant, has produced lead; at a less distance eastward manganese is raised in abundance. I have put into the box some quartz crystals from the same spot, which appear curiously formed; also a specimen of granite, and a substance that has much the appearance of jasper, which I think is formed by the infiltration of silicious matter."

Being desirous of personally visiting the place I went to Exmouth, and Mr. Loscombe was good enough to accompany me to Wolley, where we had an interview with the owner, Mr. Ellis, who conducted us to it.

On examining the interior of the excavation, the gossan, or what was termed the vein, appeared a ferruginous clay of various shades of brown and yellow, in some places compact, in others loose and like ochre.

On gently striking it with a hammer, the sound, in some places, was such as to indicate it was not firm: this furnished me with the idea that the fossil might most probably be found there: crystals of tourmaline and apatite were upon many of the pieces laying about the pit, but they were in general imperfect, mutilated, or unweildy blocks. After passing four or five hours here, and procuring a few specimens, it was agreed that a regular trial should be made the day following. Accordingly proper tools were procured, and on arriving at

Wolley early the next morning we found two men at work in the pit. One of them becoming fatigued I handled the hack, and was fortunate enough to discover a cavity, partly filled with wet clay; well knowing this must be the place for crystallization I was fearful of going incautiously to work, but after a moment's pause I took a handkerchief and tied hay in it, so as to form a bundle, which I gently introduced into the cavity, and afterwards cut away as much as I could of the exterior; I then wrenched the boundaries apart with the lever, and took the uppermost piece out with great care, and observing some of the earthy matter fall from it, I gave it to the farmer to hold, whilst I reached what had fallen. A minute could not have elapsed before I was on my feet to replace it, when, to my surprise, I found him in the act of taking a fork from the inside of his coat "*to dress it*," as he said; meaning to scratch and scrape off the clay. It was now accounted for how all the apatite crystals which had been received, were so mutilated, as he told me with an air of truth that he "*dressed* them all with this fork to send them away clean." On examining the piece, I found it covered with large crystals of apatite; not daring to remove any of the earthy matter, and replacing what had fallen, I proceeded to collect the remainder, and from this cavity many excellent specimens were obtained.

This method of filling cavities in veins when beset with crystallizations, I have seen practised in the mines in Derbyshire, and it cannot be too strongly recommended, as it secures them from breakage by falling, and insures obtaining the specimens in the greatest perfection. Before the close of the day, and whilst the men were laboriously employed, I packed a variety of pieces, and dispatched them for London. I visited the place the next day, and did not see any leading features to indicate that more would readily be found; on the contrary, after minute examination, the gossan appeared hard, and in some places lost, patches of tourmaline became disseminated in the granite, and general appearances were not favourable.

About two months ago I made a second visit to this place, and was informed by the farmer, that two men had been

working for three days, and had not "*raised a stone.*" I found the men at work, the pit much enlarged, great pieces of granite in all directions, with tourmaline disseminated through them. I cannot say I was disappointed, except from reports: on the one hand, I heard, of gentlemen going into the pit and loading themselves with much better specimens than had hereto appeared; and, on the other hand, that the walls built with it, contained the most interesting specimens; whilst penetrating mineralogists, in every direction, pretended to be the discoverers, even after it had been exposed in my window for sale!

After proceeding into Cornwall, in October, and remaining there near six weeks, I returned again to the tourmaline mine, and found it as I left it. Mr. Ellis told me, some gentlemen wished to work it to search for tin, and that his terms were, to receive one hundred guineas first, to reserve the tourmaline, and to have one-fourth of the metal obtained; but in case of the work being abandoned, the place was to be filled again, at the adventurers' expense.

I am, Sir, yours, &c.

149, *Strand.* J. MAWE.

III. Vauquelin *on the Sulphurets. From the Annales de Chimie, for September,* 1817.

M. Vauquelin has lately published an account of some researches on the alkaline sulphurets, made with the view of ascertaining the state of the base in them. They possess considerable interest from the light they throw on the nature of these compounds, and we think, that a short account of them and the conclusions drawn by that chemist, will be acceptable.

M. Vauquelin first proceeded to examine the gaseous matter given off during the combination of sulphur with potash. The substances used were carbonate, or sub-carbonate of potash and sulphur: these heated together, gave off carbonic acid and sulphuretted hydrogen, a sulphuret remaining in the etort. The carbonic acid is easily accounted for, and M.

Vauquelin appears to conclude, from repeated experiments, that the sulphuretted hydrogen comes from the small portion of water retained by the salt used. We are induced, therefore, to suppose, that pure sulphur and pure potash, would combine without the evolution of any gas.

After ascertaining, that the solution of the sulphuret of potash in water, contains sulphuric acid, suluhretted hydrogen, and potash, and that though sulphuretted hydrogen be liberated by the action of an acid on such a solution, it was previously formed and existed. M. Vauquelin, first supposing that the alkaline sulphurets are combinations of the sulphur with the oxides, that (as his experiments indicate) the half of the sulphur they contain, is combined with the elements of decomposed water, and converted into sulphuric acid and sulphuretted hydrogen on solution in that fluid; and that the solutions are sulphuretted hydrosulphurets of oxides, asks, what is the power which effects the decomposition of the water when the sulphurets are dissolved in it?

The author, after noticing Berthollet's opinion, that it is the affinity of the alkali for sulphuric acid; gives us to understand (and it appears to be the opinion the paper is intended to support), that the alkaline sulphurets may be considered as compounds of the sulphurets of potassium or sodium, and the sulphates of the same bases formed during the fusion of the alkali and the sulphur; the existence of the sulphate being inferred from the non appearance of sulphurous acid at the time of fusion, and that of the sulphuret of the alkaline metals from the production of sulphuretted hydro-sulphurets at the moment of solution in water.

It is shewn, by experiments on potash and barytes, that the quantity of sulphuric acid found in the solution of alkaline sulphurets, is as the quantity of sulphur originally combined with the base. It is shewn also, that the quantity of sulphur which combines with the different alkaline bases, is in the same proportion as the respective quantities of oxygen; so that the alkaline oxides and metals follow the same laws as the common oxides and metals; but they differ

from them in this circumstance, that they unite with more sulphur than is necessary when converted into sulphuric acid, to saturate the oxides resulting from the metallic bases.

M. Vauquelin draws further arguments in favour of the opinion already advanced, from a comparison of the sulphuret of potassium, formed by the direct union of the two elements with that obtained by the union of sulphur with potash, and also the sulphuret produced by heating together sulphur and the hydro-sulphuret of potash. The latter is a transparent reddish brown body, which when dissolved in water, gives very little sulphuric acid to barytes. The sulphuret made directly from the metal and the combustible, had a similar transparency and colour, and when dissolved in water, gave no precipitate with muriate of barytes. The sulphuret of potassium, when put into water, like both the other sulphurets, formed a sulphuretted hydro-sulphuret.

It does not seem likely that a pure sulphuret of potassium can be formed by the action of sulphur on potash; because a portion of sulphate of potash is formed, which being unalterable by the combustible, though in excess, remains mixed with the sulphuret, and contaminates it. But the substance obtained by the action of sulphur at a high heat on the hydrosulphuret of potash, appears to have been almost a pure binary combination. It is doubtful, from the description of the experiment, what was the author's opinion on it.

There are no other striking arguments in the paper in favour of the explanation given of the alkaline sulphurets, except, perhaps, that contained in the observations made upon M. Berthollet's experiment of dissolving the sulphurets in alcohol: he always found sulphate of potash, and this M. Vauquelin conceives to be in consequence of its formation at the time the sulphuret was made.

M. Vauquelin has introduced into the Paper, an extensive series of experimental observations on the compounds of alkalies with sulphur, sulphuretted hydrogen, sulphurous acid, and sulphuric acid. Although these contain much information concerning the habitudes of, and changes suffered by

these compounds, they do not apply directly to that part of the paper, or rather of theory, which it was the intention here to notice.

The composition of such sulphurets as are noticed in the paper, is given as follows:

Potash	47.3	Soda	38	Lime	74	in the dry way.
Sulphur	52.7	Sulphur	62	Sulphur	26	
	100.0		100		100	

Lime	60	in the humid way.	Barytes	65.5
Sulphur	40		Sulphur	34.5
	100			100.0

A table is also given of the comparative quantities of sulphur and sulphuric acid necessary to saturate the alkaline bases. It is as follows:

1.	100 parts of sulphate of barytes contain	34 of acid
	100 parts of sulphuret of barytes contain	34 of sulphur.
2.	100 parts of sulphate of soda (dry) contain	64 of acid.
	100 parts of sulphuret of soda	62 of sulphur.
3.	100 parts of sulphate of lime (dry)	58 of acid.
	100 parts of sulphuret of lime, obtained by boiling sulphur and lime in water	63 of sulphur.
4.	100 parts of sulphate of potash (dry)	47 acid.
	100 parts of sulphuret of potash	52 7.

But, observes M. Vauquelin, the quantity of acid in the sulphate of potash, is probably too little; according to the quantity of oxygen contained in the potash, the salt ought to contain about 52 of sulphuric acid, which is very near the result of sulphur given in the table.

The paper, terminates by a series of conclusions, among which are the following:

The quantities of sulphur which combine with the alkaline oxides, are proportionate to the quantities of oxygen to which these metals can unite; and thus a perfect resemblance is established between sulphur and the acids in this respect.

The quantities of sulphur in the sulphurets, except that of

lime obtained by heat alone, are exactly the same as of sulphuric acid, in the corresponding sulphates.

The sulphuret of lime exerts a less affinity for sulphur than the other sulphurets, for in dissolving in water, it constantly forms a simple hydrosulphuret, the others giving sulphuretted hydrosulphurets. This, perhaps, depends on the difference of fusibility.

The sulphuret of soda, and without doubt that of potash, appear to decompose alcohol, by absorbing the oxygen and hydrogen, and setting the carbon at liberty.

Certain metallic sulphates are decomposed and converted into sulphurets by sulphur at a high temperature.

Carbon, at a high temperature, decomposes the base of sulphate of potash, and converts it into a sulphuret of potassium.

It is probable, but not as yet demonstrated, that in all the sulphurets made with alkaline oxides, at a red heat, the latter lose their oxygen, and are united to the sulphur in the metallic state, as happens to the other metallic sulphurets.

IV. *Miss M'Evoy.*

An account has appeared in the newspapers and in a philosophical Journal* of a blind young woman at Liverpool possessed of most extraordinary powers in the organs of touch, and a work has been written, by a medical gentleman, expressly on the subject. These powers are stated not to depend upon an improvement of the sense of feeling by habitual exercise, nor even upon a preternatural sensibility of feeling, but upon the actual formation of an optical organ in the skin of the fingers, hands, &c. She is said to *feel* the hour of the day *through* the plate of a watch-glass, and to distinguish colours and objects *reflected* by a mirror. Whoever considers the nature of the eye, and of the sense of vision, must pronounce the case to be no less than miraculous. Dr. Darwin, in his loose speculations on organic life, has traced an irritable

* Dr. Thomson's.

fibre becoming sensitive, and by its appetencies acquiring the organs necessary for its existence. This case affords the *only accredited fact* we believe yet on record in favour of his hypothesis. A young woman is blind, and has an appetency for the sense of vision, and she gains not two eyes as a compensation for those she had lost, but ten, one in each of her fingers, besides occasional ones in the back of her hand and her cheek.

There seems to be an extraordinary sympathy and connection, we are informed, between these newly produced organs and those she has lost; for we have heard that on a book being presented to her having blue paper on one side and yellow on the other, she felt the part uppermost and said that it was blue, and on being asked what the under colour was, she turned round the book so as to bring it *into her natural sphere of vision,* and then said it was yellow. There can be no doubt that she sees, and some persons may suppose not with her fingers.

V. *Extract of a Letter from Capt.* Krusenstern *to Capt.* Burney.

"It gives me pleasure to inform you that within these few days we received letters from Lieut. Kotzebue. On leaving Kamtschatka in the beginning of July 1816, he sailed through Behring's Straits, and was fortunate enough to range the coast of America till the latitude of 67°. when he discovered a large inlet extending far to the eastward. Not being able to explore the whole of it he was obliged to leave it, but he intends to explore it this year. I do not believe that a a communication between the North Pacific and the Atlantic Ocean exists, but the discovery of this inlet does not altogether deprive me of the hopes that such a communication may yet be found; I only fear that Lieut. Kotzebue on going to this inlet may, on exploring the interior of America bordering upon it, run the risk of not being able to return by Behring's Straits, which in the latter end of September, are probably closed with ice."

Revel, Oct. 1, 1817.

VI. *American Sea Serpent.*

In the month of August 1817, it was currently reported on various authorities, that an animal of very singular appearance had been recently and repeatedly seen in the harbour of Gloucester, Cape Ann, about thirty miles distant from Boston. It was said to resemble a serpent in its general form and motions, to be of immense size, and to move with wonderful rapidity; to appear on the surface of the water only in calm and bright weather; and to seem jointed, or like a number of buoys or casks following each other in a line.

In consequence of these reports, at a meeting of the Linnæan Society of New England, holden at Boston on the 18th day of August, the Hon. John Davis, Jacob Bigelow, M. D. and Francis C. Gray, Esq. were appointed a Committee to collect evidence with regard to the existence and appearance of any such animal, and have since published a very copious report, from which the existence of the animal is placed beyond doubt. We are sorry only to have room for the following extract from the evidence, which however will give our readers, some notion of his aspect and behaviour.

Sir,

You request a detailed account of my observations, relative to the serpent. I saw him on the fourteenth ultimo, and when nearest, I judged him to be about two hundred and fifty yards from me. At that distance I judged him (in the largest part) about the size of a half barrel, gradually tapering towards the two extremes. Twice I saw him with a glass, only for a short time, and at other times, with the naked eye, for nearly half an hour. His colour appeared nearly black—his motion was vertical. When he moved on the surface of the water, the track in his rear was visible, for at least half a mile.

His velocity, when moving on the surface of the water, I judged was at the rate of a mile in about four minutes. When immersed in the water, his speed was greater, moving, I should say, at the rate of a mile in two or at most three minutes. When moving under water, you could often trace him

by the motion of the water, on the surface, and from this circumstance, I conclude he did not swim deep. He apparently went as straight through the water, as you could draw a line. When he changed his course, it diminished his velocity but little—the two extremes that were visible appeared rapidly moving in opposite directions, and when they came parallel, they appeared not more than a yard apart. With a glass, I could not take in, at one view, the two extremes of the animal, that were visible. I have looked at a vessel at about the same distance, and could distinctly see forty five feet. If he should be taken, I have no doubt that his length will be found seventy feet, at least, and I should not be surprised, if he should be found one hundred feet long. When I saw him I was standing on an eminence, on the sea shore, elevated about thirty feet above the surface of the water, and the sea was smooth.

If I saw his head, I could not distinguish it from his body; though there were seafaring men near me, who said that they could distinctly see his head. I believe they spoke truth; but not having been much accustomed to look through a glass, I was not so fortunate.

I never saw more than seven or eight distinct portions of him above the water, at any one time, and he appeared rough; though I supposed this appearance was produced by his motion. When he disappeared, he apparently sunk directly down like a rock.

Capt. Beach has been in Boston for a week past, and I am informed that he is still there. An engraving from his drawing of the serpent has been, or is now, making in Boston; but I have not been able to ascertain how far his drawing is thought a correct representation.

Respectfully, Sir,

your most obedient,

LONSON NASH.

Honourable John Davis.

I, William B. Pearson of Gloucester, in the County of Essex, merchant, depose and say: That I have, several times,

seen a strange marine animal, that I believe to be a serpent, of great size. I have had a good view of him only once, and this was on the 18th of August, A. D. 1817. I was in a sail boat, and when off Webber's cove (so called) in the harbour of said Gloucester, I saw something coming out of the cove; we hove to, not doubting but that it was the same creature that had been seen several times in the harbour, and had excited much interest among the inhabitants of Gloucester. James P. Collins was the only person with me. The serpent passed out under the stern of our boat, towards *Ten Pound Island;* then he stood in towards us again, and crossed our bow. We immediately exclaimed, ' here is the snake !' From what I saw of him, I should say that he was nothing short of seventy feet in length. I distinctly saw bunches on his back, and once he raised his head out of the water. The top of his head appeared flat, and was raised seven or eight inches above the surface of the water. He passed by the bow of the boat, at about thirty yards distance. His colour was a dark brown. I saw him at this time about two minutes. His motion was vertical. His velocity at this time was not great; though at times, I have seen him move with great velocity, I should say at the rate of a mile in three minutes, and perhaps faster. His size I judged to be about the size of a half barrel. I saw Mr. Gaffney fire at him, at about the distance of thirty yards. I thought he hit him, and afterwards he appeared more shy. He turned very short, and appeared as limber and active as the eel, when compared to his size. The form of the curve when he turned in the water, resembled a staple; his head seemed to approach towards his body, for some feet; then his head and tail appeared moving rapidly, in opposite directions, and when his head and tail were on parallel lines, they appeared not more than two or three yards apart.

Q. At what time in the day was this?

A. Between the hours of five and six, in the afternoon.

Q. How many distinct portions of it were out of water at one time?

A. Ten or twelve distinct portions.

Q. Can you describe his eyes and mouth?

A. I thought and believe, that I saw his eye at one time, and it was dark and sharp.

Q. How did its tail terminate?

A. I had not a very distinct view of his tail; I saw no bunches towards, what I thought the end of his tail, and I believe there were none.

WILLIAM B. PEARSON.

VI. *Superior Free-stone, from Collalo, Fife, in Scotland.*

THIS excellent stone having been recently introduced into the metropolis, with the most perfect success, the proprietor has requested us to insert the following notice respecting it.

Collalo stone is perfectly equal in composition, and of a beautiful colour, free from even an approach to defect: its durability is proved by Balmuto tower, in Fifeshire, which is many hundred years old, and in which no symptom of decomposition has yet appeared in any stone of the building; for ornamental and durable architecture, it stands decidedly unrivalled. It is a fact universally allowed and lamented, that the materials of many of the most noble structures in town, are not capable of resisting the effects of our variable climate; but are in a state of perpetual decomposition, and require incessant repair. The present proprietor has possessed the Quarry only for a few years, during which time he has furnished stone for a number of public as well as private buildings, viz. the *Penitentiary* at Millbank, (to which, as a specimen he refers in London) a church and prison at Trinidad; a cathedral at Gottenburg; a portico at Minto castle, in Scotland, consisting of a suit of columns in one stone, each 13 feet high; a bank, &c. at Perth; several other public as well as private buildings in Scotland; and in every instance the stone has been used with the most unequivocal approbation.

Every possible proof of the qualities of Collalo stone will be satisfactorily given, but all its properties cannot be here enumerated; it is easily worked, and the price moderate. A sample may be seen at Mr. Stodart's, 401, Strand.

Copy of a Report from Professor Leslie and Dr. Murray of Edinburgh.

"Agreeably to your request, we have submitted to some chemical trials the specimen of sandstone from your quarry (Collalo stone), and that from Yorkshire (Roach Abbey) which accompanied it, with a view to their comparative durability for architecture. The first is a very pure silicious sandstone, it scarcely contains any trace either of carbonate of lime or of iron. The other is not a sandstone but a magnesian limestone; its texture is compact and close grained, which gives it a superiority; how far it may be liable to disintegration from its chemical composition it is difficult to determine, but it is important to remark, that some magnesian limestones, apparently very close grained, decay within no very long period, from the action of the air.

Edinburgh, 31*st July*, 1817.	(signed)	JOHN MURRAY.
	(attested)	JOHN LESLIE.

VII. *Case of Poisoning by Muriate of Barytes.*

A case of poison has lately occurred from muriate of barytes, an ounce of which in solution was taken by a girl for Glauber's salts by mistake. The instant she swallowed the liquid she said she was on fire; vomitings, convulsions, pain in the head, and deafness immediately supervened, and death occurred within an hour from the time of injection of the poison. Every day shows the necessity of some legislative interference respecting the general and incautious sale of deleterious drugs.

VIII. *New Works on Botany and Chemistry.*

The next number of the *Botanical Register* will contain a figure of a beautiful and undescribed species of *Bignonia*, from the Brazils, which lately flowered in the collection of the Countess of Liverpool. We consider this work as unquestionably the most important of the periodical botanical publications on account of the excellence of Mr. Edward's drawings, the variety of new and elegant plants figured, and of the critical acumen displayed in the descriptions.

A Botanical work in folio, printed from stone, consisting of coloured figures of rare plants, will be published in the early part of this year. The figures are taken from the collection of Chinese* and Indian drawings in the possession of William Cattley, Esq.

Mr. Children is now engaged in translating that part of the fourth volume of Thenard's System of Chemistry relating to Chemical analysis, and proposes to extend it by the addition of much new matter. This will be a valuable acquisition to the practical chemist. It will probably be ready in the ensuing spring.

IX. *Note respecting the improvements in Covent Garden Theatre.*

The lighting, warming, and ventilation of this theatre having attracted considerable attention, we have much pleasure in being able to furnish our readers with a short account of the methods by which such important desiderata have been so perfectly attained.

During the last season a number of experiments were instituted by Mr. Harris, with a view of introducing gas illumination; but on account of the heat and smell which it produced, the plan was postponed until the summer recess admitted of more extended trials, which, as we need not say, have been perfectly successful.

The great central chandelier, containing eighty batswing burners, is suspended under a funnel which terminates upon the exterior of the building, so that the smell of the burned gas, or any that might escape unburned is effectually carried away. The intense heat also occasions a considerable current of air, which rushing unpwards, tends materially to the ventilation of the house; but besides this, ventilators are placed in many parts of the building, which communicating with the great tube of the chandelier, are continually drawing foul air from the audience part of the house. So that the gas light chandelier not merely illuminates, but is also a powerful agent in the ventilation of the theatre.

The fresh air with which the house is supplied, is admitted at any desired temperature, an effect attained by air pipes and stoves placed at all the entrances, and under the different corri-

dores of the pit and boxes, while the influx of cold air from the stage, which is often so annoying to the spectators upon the drawing up of the curtain, is prevented by similar means; but here, in consequence of the danger which might accrue from stoves, on account of the inflammable nature of the machinery, the air is chiefly heated by steam, which is supplied from an engine boiler securely placed in a vault near the stage entrance.

The gas, which is supplied by the Westminster Company, is conducted into the theatre by two three-inch mains of cast iron, securely cased and defended from accident, and there are on the stage proper register cocks, by which the intensity of the light may be regulated in every part of the building.

In case of any failure in the supply of gas, very ingenious means have been devised, by which the house may in a few minutes be lighted with candles in the usual way. We understand that Mr. Riddel, M. de Chabannes, and Mr. Symmons, are the persons whom Mr. Harris has employed in the execution of these improvements.

X. *Scientific Intelligence.*

The Rev. William Alleyne Barker has published a Table of Logarithms of all numbers from 1 to 10,000: together with a Table of Lines and Tangents, a Transverse Table, and several others, which will be found particularly useful, as being in a pocket size, and carefully corrected by himself. W. and P. Reynolds, 137, Oxford-street.

Mr. Jones of Charing-Cross has just published a new edition of that highly useful Planisphere originally invented and published by the late James Ferguson, Esq. F.R.S. called the Astronomical Instrument, and which the public have been long debarred from obtaining by its having been many years out of print. Mr. Jones purchased the plates at the sale of astronomical instruments of the late William Walker, Esq. and has had them corrected to the present time.

Mr. Schmalcalder, Philosophical Instrument maker in the Strand, has just completed a very important and useful improvement in the Theodolite, by which it admits of eight proofs

of adjustment in the field without delay, and the possibility of error is almost prevented. The account of it came too late for insertion in the present Number, but will be noticed in a future one.

XI. *Royal Institution.*

The second course of the morning Lectures delivered in the Laboratory will begin early in February next. The following arrangements have been made for the season :—

On the Principles of Chemical Science and their applications to the Arts. By W. T. Brande, Esq. Sec. R. S. London, and F. R. S. Edin., Prof. Chem. R. I.

On Experimental Philosophy, embracing the subjects of Magnetism and Electricity, and their influence on the arrangements of matter. By John Millington, Esq. Civil Engineer, Prof. of Mechanics to the Royal Institution.

On Practical Mechanics and the Manufacturing Arts, being a continuation and conclusion of the course of the last season, and comprehending an examination of Wind as a prime mover;—of the Steam Engine in its progressive stages of improvement, with an account of some of the principle purposes to which it is applied, and the motive force of Gunpowder and Elastic Vapour. By the same.

On the Connexion between Poetry and Painting. By W. M. Craig, Esq. To be delivered gratuitously.

The Monday evening meetings of the Members of the Royal Institution to be held in the great Library, will commence on the first Monday in February at 8 o'clock, and will be continued on each succeeding Monday (the Easter holidays excepted,) until the first Monday in July 1818. These meetings are open to the members of the Institution, and to such persons as they wish to introduce for the purpose of trying experiments, exhibiting specimens of novelty and curiosity connected with the Sciences and Arts, and discussing the same, together with any researches or discoveries which may from time to time be produced, and which the public are invited to send to them for such purposes.

Thomas Harrison, Sec.

Art. XXIII. *Analytical Review of Foreign Journals, published on the Continent in* 1817.

The foreign journals of last year, have not been very fruitful in either new or important matter. To follow their march, as we had at first undertaken to do, we find next to impossible, owing to the irregularity of their publication. We had, it is true, adopted measures the most likely to insure to our readers an insight of their contents, in order that they might judge from them of the progress of the various branches of science on the Continent; but we could not foresee the many circumstances which have occurred to frustrate, in part, our intention. With a large mass of those journals now before us, of which we have as yet said nothing—and little room left in the present Number, already greatly extended, for our observations, it cannot be expected, that we shall be able to do justice to the subjects on which we shall have to speak. We will use our best endeavours, by a new, but provisionary method, to satisfy the curiosity of those readers who have been pleased to find, in this part of our Journal, both amusement and information: and we must rely on the future regularity in the publication of Continental Journals, which, in regard to one, and the best of them, seems already to be the case, for inserting in our own Journal, an analytical account of their contents. We shall now proceed to take notice of the most important papers that have appeared in the four principal French publications, during 1817, under the various heads of general science.

Chemistry.

In this branch of experimental philosophy, the *Annales de Chimie*, stand pre-eminent. M. Chevreul, in a memoir published in January, has shewn, that the primitive or permanent colour of what is called *cameleon mineral*, a combination of potash and oxide of manganese, is not blue, as first stated by Scheele; and that when it passes from the green to the red colour, the transition is gradual, and according to the theory of the coloured rings, by being alternately green,

blue, violet, indigo, purple, and red. He conceives that the cause of these colours is to be ascribed to the potash acting on the oxide of manganese, which in this case may be considered to possess the property of certain colouring principles of vegetables, which are rendered green by alcalies, and red by the action of acids.—M. Gay Lussac has had occasion to examine a carbonaceous substance found in the furnaces of the manufactories of porcelain. It presents itself under the form of slender and elongated fibres, straight, or with an angular joint, rarely curved, irregularly disposed among themselves, and of a grayish colour. Heated in a glass tube, it gave out much carbonic acid, but shewed no signs of containing hydrogen gas. Heated with the oxide of mercury, it left no residue, by which the author concludes it to be pure carbon in a crystallized form.—The same gentleman has proposed a simple mode of improving Volta's eudiometer, by which the two inconveniences of either losing part of the gas under examination, or of forming a vacuum within the instrument, are easily obviated. (*January.*) In the same number will be found, a short but interesting account, by the same author, of the late of Mons. Descotils, Professor of Chemistry at the Ecole des Mines.—To Mons. Gay Lussac, we are indebted likewise for a new method of obtaining pure alumina. It consists in employing the sulphate of alumina, combined with ammonia, instead of potash. The salt being heated, a decomposition takes place, and the earth remains behind in its purest state. (*May.*) Volta's lamp, in the hands of Gay Lussac, has become the readiest means of procuring light, and any quantity of hydrogren gas, when wanted for chemical experiments in a laboratory. (*July.* In a letter to this distinguished chemist, from Berzelius, we find, that M. Arvidson has obtained the three distinct oxides of manganese, the existence of which had been previously deduced from calculation by Berzelius himself The protoxide is green, the two others black. The second was obtained by heating the nitrate of manganese to a red heat. (*October.*) The most important papers in the whole collection, however, are those of Professor Vauquelin. The first is relative to the combinations of platinum with

sulphur and other substances, and to the oxides of that metal. With regard to the sulphuret of platina, he is certainly the first who has obtained it in a direct way, and has demonstrated its properties and its proportions by several experiments. It is not decomposed by heat, and the acids have no action upon it. Its form is that of a powder, black, and shining like the oxide of manganese. (See p. 74 of this Vol.) (*July*) The other paper is upon the alcaline sulphurets, an extract of which will be found in the present Number.

A note on some triple salts of platina, has also been given to the public by the same author. These are formed by mixing a neutral muriate of platina and a muriate of soda. A triple salt is the result which crystallises readily in fine crystals of an orange red colour. If, on the contrary, caustic soda is mixed with muriate of platina, the salt resulting from it has different properties, and crystalline forms peculiarly its own. Mons. Vauquelin found, that by treating the submuriate of platina with a considerable quantity of sulphuric acid, and a strong heat, he could obtain a sulphate of platina, which, when mixed with the sulphate of potash, gave rise to a triple sub-sulphate of platina and potash, insoluble in water. (*August.*) Mons. Beudant, in a memoir on the mutual assistance which chemistry and crystallography may derive from each other, has shewn, that a foreign substance may be mixed with a salt, without altering its essential form. From his experiments, it appears, that the form of the sulphate of iron, for instance, continues unaltered, even when 97 per cent. of sulphate of copper are present. (*January.*) MM. Freycinet and Clement, have repeated the trials, so often attempted in this country, of rendering sea water potable by distillation.—Some more experiments on the combination of the oxide of manganese and potash, by MM. Edwards and Chevillot, have been undertaken, to disprove some of the notions entertained on this chemical Proteus. (*March.*) A practical paper on a new mode of assaying gold, by Mons. Chaudet, is contained in the same Number, of which we gave an account on a former occasion.—The same gentleman has also given a memoir on the action of muriatic acid on the

alloys of tin and bismuth. (*June.*) A note on the history of the dry Galvanic piles, is again inserted in the Number for that month. We have so often expressed our opinion on this subject, that we are not disposed to waste our time by recurring to it once more.

We have already laid before our readers, the important paper of Messrs. Magendie and Pelletier on emetine; and the memoir of Serthurner on morphium, or morphine :—since then, Mons. Robiquet has proposed an easier method of separating that principle from opium, by means of magnesia, instead of employing ammonia, as originally suggested by the discoverer. (See p. 159 of this Vol) *(July.)* We have somewhere given the result of some experiments made by Mons. Rhulant, with a view of ascertaining the quantity of atmospheric air absorbed by different bodies. It results from his inquiries, that neither the liquid nor the solid bodies, become ever saturated with oxygen gas; that the liquids may be made to absorb a second proportion, when kept long in contact with atmospheric air enclosed in bottles; and that the same happens to *solid bodies*, when damp and exposed to a high temperature. Atmospheric air seems to possess the property of depriving all bodies with which it remains in contact of a portion of their oxygen; a circumstance which explains the impossibility of their ever becoming saturated with that gas. (*February. Journal de Physique.*)—An account of the work of Monsieur Caventon on the new nomenclature of Thenard is inserted in this number. It is to be lamented that men, otherwise eminent and justly celebrated, should lose their time in *making* names, without any correct meaning, when the old ones would do very well. The necessary consequence is that they fall into a sorrowful jumble of, words tending to throw disrepute on science amongst the ignorant, and perplexity even among the adepts. Then the contradictions are innumerable. Take this for example: the termination *ic* has been adopted by the moderns of all nations, in regard to acids, to designate those that are rendered so by oxygene; hence the chloric acid or *acide chlorique* of the French for the combination of chlorine and oxygene. Now by adding the word *hydro* before

it, (which by the bye would imply *water* and not *hydrogene*) it is attempted to designate a simple combination of *hydrogene* and *chlorine*, or the muriatic acid; whereas, according to their own rule, and indeed to the all common rules of the language, *hydrochlorique* would imply either an acid formed by chlorine and oxygene mixed with water; or, what is still more preposterous, an acid composed of hydrogene + chlorine + oxygene. A similar objection obtains in regard to the hydro-sulphuric acid, for the sulphuretted hydrogene gas, and *sic de cæteris*. Then as to the elegance of the new compound names: *azotic acid* stands for the nitric, and *azotated hydrogene* for ammonia. The nitrate of ammonia, therefore, may be called an *azotate* of *azotated hydrogene*; which, considering that it is the salt from whence we obtain the gas that excites laughter, is really not amiss.—The memoir of Mons. Braconnot, on extracts in general, and the extractive principle, is worthy of much attention. He seems to have studied this matter thoroughly, and the results of his investigations may one day become useful. He divides *extracts* into five *genera*, the 1st comprehends the extracts containing azote, and slightly bitter; the 2nd, extracts with azote, and very bitter; the 3rd, extracts with azote, and hydrogene, very bitter; the 4th, extracts with oxygene; 5th, extracts with oxygene, and very bitter. Each genus has its peculiar and distinctive characters, which seem to be ably traced; and every species enumerated has been analysed by the author. A singular conclusion to which he is led is this: that there exists no such a thing as the extractive principle so much spoken of in vegetables. (*April*, and *May*. *Journal de Physique*.) A very considerable quantity of native sulphate of magnesia has been found in Aragon near the town of Calatayad. Some specimens of this beautiful mineral have been forwarded to this country. It is a salt absolutely neutral, very fusible in its own water of crystallization, and in dissolving it produces a considerable degree of cold. It appears from three sets of analytical experiments made by MM. Theran, brothers, that the elements of this salt are water 5.00, sulphuric acid 3.32, magnesia 1.62, soda (traces of.) (*July*. *Journal de Physique*.) A valuable paper from M.

Vauquelin is found in the number for August of the same Journal, giving a detailed account of several analysis of potatoes, made by order of the Society of Agriculture, with a view of ascertaining the proportion of nutritive matter in the different varieties of that root. M. Vauquelin operated on forty-seven varieties.—The same gentleman has also analysed *rice*, and we recommend his paper to the notice of our readers. (*August. Journal de Physique.*) A new description of the natural fires of Pietra Mala is given by Mons. Thenard de la Groye, with an explanation. Mons. de la Groye is neither a mineralogist, and certainly not a chemist, to our fancy. We cannot say any thing of his paper.—An account is given in the same Number, of Orfila's late work, which he has been pleased to entitle Medical Chemistry. We have seen the work; and would have been tempted to say something of it in a separate article; but really it is a very disagreeable task to speak at all, where the objects of praise do not at all balance those of a contrary tendency. We feel the more unwilling on this subject, as the author enjoys already, and very justly, a great share of reputation. Shall we say that we were sorry for him when we closed his two volumes? Of this we can assure our readers, that in this work of *Medical* Chemistry, the thing the least spoken of is the application of chemistry to medicine; and surely the French had no need of another chemical compilation, so soon after the valuable work of Thenard. (*September. Journal de Physique.*) Mons. Meyrac, junior, has published a short paper on the action which water seems to have on the neutrality of the alkaline acetates, tartrates, oxalates, citrates, and borates; he thinks that they become acid by the simple addition of water. (*May. Bulletindes Sciences,*) —In the same number M. Laugier, again asserts that *all* the regularly crystallized arragonite contains a quantity of strontian, however different in opinion M. Bucholz and Meissner might be.—Mons. Chevreul has ascertained, since his previous inquiry, that what he called cetic acid, is a compound of margaric acid and a fat substance without any acid property. —MM. Pelletier and Caventon have studied the action of nitric acid on the *cholesterine* of human biliary calculi, and

seem to believe in the existence of a new acid resulting from it. (*July. Bulletin des Sciences.*)—A table of the component parts of some animal substances has been given by M. Berard, who in analysing them, has employed the peroxide of copper, as first proposed by Gay Lussac. The substances analysed are urea, uric acid, butter, lard, mutton suet, cholesterine, cetine, and fish oil. The two former, only, contain azote; the first in the proportion of 43.40 per cent. in weight, and the second 39.16. (*August. Bulletin des Sciences.*)—In a memoir read at the Academy of Munich, M. Vogel has shewn that to render cream of tartar soluble by the assistance of boric acid, four proportions of the former and one only of the latter should be employed. The proportions indicated by Thenard cannot, therefore, be correct. The soluble cream of tartar crystallizes with difficulty owing to its great deliquescence; and remains in the form of a fluid when properly prepared. During the operation a considerable quantity of tartrate of lime is deposited. One hundred parts of this salt require but seventy five parts of cold and only fifty parts of hot water, for its complete solution. Is the solubility of the cream of tartar in this case due to a chemical combination of the boric with the tartaric acid?—Mons. Bouillon la Grange has asserted that the common manna, may be separated into two distinct portions; the one crystallizes, and seem to be the pure manna, and not sugar, as some chemists have pretended; the other, which does not crystallize, is a substance having no analogy to manna, and giving, most probably, to the latter its nauseous taste. (*January. Journal de Pharmacie.*)—The same gentleman has confirmed by experiments, Gehlen's idea of the existence of a free acid in amber. He thinks it might be obtained by the action of water on amber, if means could be devised of keeping it in fusion during the operation. In the course of his experiments he found that linseed oil gradually heated to the boiling point, over amber, renders it flexible. (*February. Journal de Pharmacie.*)—From a paper of M. Boullay, we learn that the analogy between the milk of sweet almonds, and animal milk, first pointed out by Proust, is perfectly

correct. The emulsion of sweet almonds contains 54.00 sweet oil, 24.00 albumen, 6.00 liquid sugar, 3.00 gum, with traces of acetic acid. M. Boullay thinks that the emulsive grains have not the *fæcula amylacea* for basis, as stated hitherto by all the authors, but albumen, the great quantity of which renders them indigestible.—A similar inquiry on the nature of the bitter almonds by Vogel, shews that the only difference between the two consists in the presence of a small quantity of prussic acid, and a peculiar volatile oil, the action of which, though deleterious, is particularly modified by its combination with the sweet oil, and the albumen which are present in the fruit in considerable proportions.—The very exorbitant price at which succinic acid is sold; and indeed the difficulty of obtaining it pure (that which is sold under the name of *salt of amber* being simply an acid sulphate of potash impregnated with oil of amber) induced MM. Robiquet and Colin to study in a more precise manner the mode of obtaining it by distillation. We are sorry to say that their researches have not led to any advantageous practical results.—M. La Billardière has had occasion to see some regular crystals of deutoxide of lead, formed in a phial from a solution of the oxide in soda. They appeared to be regular dodecahedrons: they are white, and seem transparent; placed on burning coals they are reduced to metallic lead; they are quite insoluble in water both cold and boiling; but perfectly soluble in nitric acid, without giving out any gas, and forming a perfect nitrate of lead.—Another example of the presence of pycromel in an human biliary calculus, has been published by M. Caventon. Our readers will recollect that M. Orfila was the first who shewed that this *principle*, stated by Thenard to be peculiar to the bile of some animals only, was to be found also in the biliary concretions of man. (*August. Journal de Pharmacie.*)—The cinnamon tree of Ceylon and Guiana has hitherto been considered as one and the same species; it was important however to know whether the bark of both was of the same nature; in order to ascertain this point Mons. Vauquelin has analysed them both, and it appears from his experiments that the difference remarked between the two depends

on the intensity of the volatile oil in the bark of the cinnamon tree of Guiana, which approaches in taste to pepper. He also observed the presence of a considerable quantity of tannin in both the barks, and he concludes by stating, that whenever either of them is given as a medicine, the physician prescribes a mixture of tannin in volatile oil, with a little mucilage and colouring matter containing a peculiar acid!—From a paper of Mons. Labillardière we find that the proto-phosphuretted hydrogen gas takes fire at the ordinary temperature in rarefied oxygen gas or atmospheric air; that each phosphuretted hydrogen gas forms a peculiar combination with hydriodic acid, having, each, particular properties; that the proportion is that of equal volumes with regard to the protophosphuret and hydriodicacid: and with respect to the combination of the perphosphuretted hydrogen with the hydriodic acid the proportions are one volume of the former, and two of the latter. (*October. Journal de Pharmacie.*)—MM. Pelletier and Caventon have ascertained that the green matter of the leaves of plants is neither a resin nor a *fæcula*, as it has been styled by various authors; but a substance *sui generis* highly hydrogenated, worthy of occupying a place in the list of vegetable principles under a new name, which the authors propose, namely, *chloriphyle.*—A new analysis of jalap has lately been given by M. CadetGassicourt in a thesis for the degree of Doctor of Medicine. It is too long and complicated to be inserted in this place.—In some recent experiments, M. Peschier of Geneva has confirmed the facts first observed by Vogel of the decomposing action of certain vegetable substances on metallic salts. (*November. Journal de Pharmacie.*)

Mechanical Philosophy.—Mathematics.

The most important work under this head which has appeared in 1817, is without doubt the one which Mons. Fourier has published on *radiating caloric*, in which all the phenomena relating to this subject are treated and explained by mathematical demonstrations. We can warmly recommend this excellent paper to the attention of our readers.—Another very interesting subject is that which Mons. Gerard has

treated in a masterly manner, namely the *écoulement* of fluids through capillary glass tubes: the result he has come to, from the various experiments he made, are very curious; amongst others we may notice that he has ascertained that the form of the *jet* of the liquid in no way influences the quantity escaping through the tube, in a given time; and consequently, that although it has been proved, that electricity changes the interrupted *jet* of a fluid into a continued one, the quantity issuing from the tube, in a given time, in such cases, is by no means encreased. (*February. Annales de Chimie.*) M. Fresnel has ascertained, by a very neat method, that heat changes in a very sensible manner the colours developed by the polarisation of light in certain substances, particularly the sulphate of lime; he suggests, as a very interesting series of experiments on this subject, to compare, by thermometrical observations, the increase of temperature of the crystal, and the corresponding diminution in the difference of the velocity of what are called the *ordinary* and the *extraordinary* rays, in order to ascertain in what relation they stand to each other. (*March. Annales de Chimie.*) Another work of much importance, but which we cannot, from its nature and length, analyze, is that of Poisson on the *Theory of Waves*, read at the Academy of Sciences, and published partially in the *Ann. de Chimie for June.*—M. Prony has succeeded in finding a means of regulating the length of the oscillations of pendulums. His method consists in the addition of a very simple apparatus placed above the edge-knife of the pendulum. (*July. Annales de Chimie.*) We have mentioned, in a former Number, the memoir of M. Laplace, in which that eminent mathematician proposes to apply his theory on the calculation of probabilities to geodesical operations. (*August. Annales de Chimie.*) M. Delcros has newly ascertained, by means of the formula of Laplace and the co-eciffient of M. Ramond, the elevation of the lake of Geneva above the level of the sea. He found it to be 373 metres 92 centimetres. This is an important subject for persons travelling over the Alps, who generally take Geneva for their point of departure. In the Number of the same Journal for October we find a very cu-

rious and elaborate memoir of M. Despretz, one of the most promising pupils and assistants of Gay Lussac, on the cooling of metals, considered as a means of ascertaining their specific caloric, and their conductibility. We cannot enter into all the details given by the author, but we shall insert the concluding table, with a view of correcting several erroneous notions entertained at this moment on this subject. (*October. Annales de Chimie.*)

Metals.	Time of cooling.		Capacity for caloric, calculated by their cooling.	External Conductibility.
	Varnished.	Polished.		
Iron	100.0	175.2	100.	100.
Cast do.	103.5	170.8	113.6	106.3
Steel	102.3	187.4	102.1	98.9
Zinc	77.6	139.1	84.6	97.6
Brass	84.0	153.3	80.6	95.9
Tin	46.5	81.6	48.6	99.2
Lead	41.2	66.2	28.6	109.0

M. Maizieres had occasion to observe, while at the island of Teneriffe, that at each impulse of the waves entering a grotto on the sea shore, the water was projected through an opening in the ground above, to a considerable heighth. He explains this by supposing that the internal air being compressed by each returning wave against the portion of water which had remained within the grotto, forces it to rise. Upon this observation the author has conceived it to be possible to raise sea water to more than 30 feet above the low water mark, to be received into salt pans, by employing the same moving force; and constructing a machine at once powerful and economic for that purpose. From calculation, he finds that such an apparatus, simple as it is, would throw up in one day 2,327 cubic metres 76 centimetres of sea water to the height of 15 metres, which is equivalent to 35914.01 cubic metres of fresh water raised 4 feet high. This force is equal to that of 323 $\frac{55}{100}$ men daily, or to that of $\frac{22}{100}$46 horses = 11.55 windmills. (*June. B. des Sciences.*) A mathematical paper, by Cauchy, on the reciprocity which exists between certain functions, has been published in the same Journal, but will not admit of curtailment.

Natural History.

Berzelius, while examining some new minerals, discovered an earth having properties peculiarly its own, to which he has given the name of Thorine.—M. Carradori has ascertained that land tortoises, which breathe by means of lungs, can live for several hours immersed in oil. (*May. Annales de Chimie.*) It having been stated that the Ornithorinchus paradoxus of New Holland, had wounded, by means of a *spur* with which it is armed, one of the servants of Sir J Jameson, Dr. Blainville was curious to ascertain the formation of that organ. He has therefore carefully examined the two individuals in the Collection of the Royal Museum at Paris, and found it to consist of an apparatus peculiar to that singular animal, composed of a sharp point, within which is a canal and a vesicle destined to contain, no doubt, a poisonous fluid; the whole being surrounded by a scaly membrane. (*April. Journal de Physique.*) A paper on the internal organization and the habits of the Scorpio occitanus of Latreille, has been published in the same Journal by Dr. Dufour, who had occasion to examine several of those insects in Catalonia; they are two inches and a half in length, and measure half an inch in diameter towards the middle of the abdomen. The account is drawn up with the utmost care.—A memoir appears also in the same Number, by M. Breton, on the mistakes committed by naturalists with regard to some of the reptiles, in which the mere changing of colour by the change of skin, has been taken as a distinctive character of a new species.—An account is inserted in the same Journal of a spring near Baaden, from which a great quantity of azotic gas is issuing daily.—M. Desmarets has, by new observations, been enabled to modify the genus shell *baculithe,* and has established a new genus underthe name of *Ichthyosarcolithe.* (*July. Journal de Physique.*) M. Blainville has shewn, by a reference to incontrovertible facts, that the elegant shell, called the Nautilus papyraceus, is not the *habitat* of a species of sepia, as some authors have asserted. The same gentleman has given an account of a new species of quadrupeds from North America, called the *Rupricapra Americana.* (*October. Journal de Physique.*) Two interesting papers on subjects of

zoology appear in the *Bulletin des Sciences*; they are by MM. Blainville and Geoffroy St. Hilaire; we have mentioned the subject of them before.—We shall not say any thing of the memoir of M. Virey on intestinal worms in the human species; it teaches nothing new; it proposes nothing that is tenable for their cure. (*September. Journal de Pharmacie.*)

Botany.

M. J. S. Hilaire has written a paper on the *Nerium tinctorium* of Roxburgh, and the *Writhia tinctoria* of Brown, in which he has carefully compiled all that has been published in this country, on the subject of plants employed for the extraction of indigo. (*Jan. Annales de Chimie.*) Our readers recollect, most probably, the name of M. Dupetit Thouars, a most excellent man, but who has the misfortune to be in opposition to all the known botanists, with respect to some of the most important points of vegetable physiology. One of these is the circulation of the sap in plants. To support his own particular opinion on this subject, M. Thouars has drawn up the history of all the experiments that have been made respecting it. (*August. Annales de Chimie.*) M. Lambry, in the same Number, proposes two circular incisions, and the removal of the insulated part of the bark of vine trees, to hasten their maturity in rainy seasons.—We have had occasion to give a pretty full account of a proposed new family of plants to be called the *Boopideæ,* by Cassini, junior: his memoir on this subject, has appeared in the Journal de Physique for February; we must refer our readers to our former statement.—M. Desvaux has enumerated the species which are to constitute the genus *Barkhansia*; they amount to twelve, divided into two sections, the character of each of which are **Involucellum distinctum scariosum*: ***Involucellum conforme.* (*June. Journal de Physique.*) M. Lehman asserts, that the genus *Coldenia,* placed by all the botanists among the *tetrandria tetragynia,* belongs to the pentandria monogynia; and he adds, that the genus Siquilia (Perou) of Persoon, is only a species of *Coldenia.* The same gentleman has established a new genus under the name of *Colsmannia.*

We might extend our account to the branches of physiology, medicine, and also to astronomy:—but the greatest part of the papers contained in the French Journals for 1817, on those subjects, have either been noticed by us already, in some shape or other; or bear too small a share of interest in the great mass of scientific information which the year has furnished, for us to waste any more of the valuable time of our readers.

ART. XXIV. *Proceedings of the Royal Society of Edinburgh.*

November 17. A paper by Dr. Ure of Glasgow was read containing experiments and observations on muriatic acid gas.

At the same meeting, a paper by Mr. Ferguson was read on the mud volcanoes of the Island of Trinidad.

December 1. A paper by Dr. Brewster was read on double refraction and polarisation.

December 15. Dr. Murray read a paper announced at the first meeting of the season, containing "experiments on muriatic acid gas, with observations on its chemical constitution, and on some other subjects of chemical theory." After some observations on his former experiments, in the controversy on the nature of muriatic acid, of procuring water from muriate of ammonia by exposure to heat, and by subliming it over ignited charcoal, he alluded to the experiment lately made by Dr. Ure of subliming it over ignited metals. To avoid any fallacy which might exist, in consequence of sal-ammoniac, which was used in that experiment containing water from its mode of prepartion, he employed the salt formed by the combination of the two gasses: and in subliming it over ignited iron found water to be produced. He then submitted muriatic acid gas to experiment. He transmitted it, (previously exposed to dry muriate of lime) over ignited iron filings in a glass tube, and found that with a production of hydrogen gas there was a very sensible deposition of water;

and in an experiment designed to obtain a more perfect result, in which zinc was submitted to the action of muriatic acid gas at a moderate heat, a larger quantity of water was obtained. The apparatus was so adapted as to exclude all extraneous moisture, and it was shewn that the result could not possibly be ascribed to hygrometric vapour. The subject is to be prosecuted in a continuation of the the Paper at next meeting of the Society.

We understand that Dr. Brewster has lately completed a series of experiments on the action of the surfaces of crystallized bodies in the polarisation of light, and that he has determined the laws according to which the forces emanating from the surface are modified by the polarising forces which emanate from the axes of crystals. As it had always been taken for granted, in consequence of some incorrect experiments by Malus, that these last forces had no influence whatever upon the first, the results obtained by Dr. Brewster must be considered as very interesting, and important; particularly as they lead to new views respecting the ordinary attraction of repulsive forces by which the phenomena of refraction and reflexion are produced.

Art. XXV. Meteorological Diary for the Months of September October and November 1817, kept at Earl Spencer's Seat at Althorp, in Northamptonshire. The Thermometer hangs in a north-eastern aspect, about five feet from the ground, and a foot from the wall.

METEOROLOGICAL DIARY

for September, 1817.

		Thermometer.		Barometer.		Wind.	
		Low.	High.	Morn.	Even.	Morn.	Even.
Monday	1	43	66	29,89	29,94	SW	SW
Tuesday	2	38	65	29,97	29,90	SE	SE
Wednesday	3	53	73	29,84	29,70	E	SE
Thursday	4	52	66	29,90	30,00	W	W
Friday	5	46	68	30,10	30,08	W	W
Saturday	6	44	71,5	30,07	30,03	W	W
Sunday	7	43	67	30,03	29,99	SSE	EbS
Monday	8	40	68	29,95	29,85	ESE	ESE
Tuesday	9	48	62	29,94	30,00	WNW	E
Wednesday	10	54	63	29,99	29,94	ENE	E
Thursday	11	43	66,5	29,97	29,93	E	SE
Friday	12	49	63	29,89	29,80	SW	WbS
Saturday	13	39	61	29,93	29,92	NE	E
Sunday	14	50	60	29,90	29,90	NE	NE
Monday	15	54	66	29,94	29,97	NE	E
Tuesday	16	59	65	29,99	29,99	E	E
Wednesday	17	55	64	29,96	29,84	E	NE
Thursday	18	55	63	29,73	29,61	NE	NbW
Friday	19	54,5	63	29,70	29,80	NW	W
Saturday	20	50	64	29,90	29,93	W	NW
Sunday	21	53	61	29,93	29,90	NE	NE
Monday	22	41	58	29,87	29,80	NE	NE
Tuesday	23	41,5	61	29,80	29,82	NE	NE
Wednesday	24	48	60	29,90	29,79	NE	S
Thursday	25	50	60,5	29,52	29,34	S	S
Friday	26	53	59	29,12	29,12	SW	SW
Saturday	27	46	56	29,25	29,28	W	W
Sunday	28	44	56	29,58	29,73	W	W
Monday	29	38	55	29,87	29,90	W	W
Tuesday	30	43	52	29,88	29,90	NW	ENE

METEOROLOGICAL DIARY

for October, 1817.

		Thermometer.		Barometer.		Wind.	
		Low.	High.	Morn.	Even.	Morn.	Even.
Wednesday	1	34	51	29,78	29,70	ENE	NW
Thursday	2	29	46	30,00	30,00	WNW	WNW
Friday	3	30	49	30,00	30,00	W	ENE
Saturday	4	31	55	30,10	30,13	ENE	ENE
Sunday	5	31	53	30,19	30,19	E	EbN
Monday	6	30	51	30,20	30,18	EbN	ENE
Tuesday	7	39	54	30,14	30,10	ESE	E
Wednesday	8	45	52	30,09	30,00	E	E
Thursday	9	40,5	53	29,97	29,90	EbN	EbN
Friday	10	41	53	29,89	29,89	ENE	NNE
Saturday	11	37,5	48	29,93	29,98	NbW	NbW
Sunday	12	34	50,5	30,00	30,02	NbW	NbW
Monday	13	36	52	30,20	30,20	N	NNE
Tuesday	14	29	50	30,20	30,13	NW	NNW
Wednesday	15	43	50,5	30,00	29,93	NbW	N
Thursday	16	39	51	29,87	29,94	NE	E
Friday	17	32,5	49	30,03	30,03	E	E
Saturday	18	31,5	47,5	29,93	29,83	NE	EbN
Sunday	19	41	48	29,88	29,87	EbN	NE
Monday	20	42	49	29,88	29,88	NE	NE
Tuesday	21	42	50	29,84	29,74	NE	EbS
Wednesday	22	40	49,5	29,73	29,78	SE	E
Thursday	23	34	49	29,90	29,90	NNE	NE
Friday	24	42	46,5	29,88	29,83	ENE	ENE
Saturday	25	40	47	29,78	29,71	E	SE
Sunday	26	35	48	29,67	29,63	SE	SE
Monday	27	32,5	46	29,60	29,35	SW	SbW
Tuesday	28	31	46,5	29,35	29,30	SW	SSW
Wednesday	29	33	45	29,34	29,40	W	SW
Thursday	30	33	47	29,10	29,20	SW	SW
Friday	31	39	50	29,40	29,54	S	W

METEOROLOGICAL DIARY

for November, 1817.

		Thermometer.		Barometer.		Wind.	
		Low.	High.	Morn.	Even.	Morn.	Even.
Saturday	1	32	45	30,05	30,21	W	SSW
Sunday	2	33	53	30,08	30,04	SbE	SW
Monday	3	50	58	30,06	30,06	SW	S
Tuesday	4	49	52	29,99	29,98	SE	SE
Wednesday	5	46	54	29,83	29,79	SE	SE
Thursday	6	49	56	29,80	29,78	SSE	SE
Friday	7	50	58	29,61	29,43	SSE	SSE
Saturday	8	48	53	29,34	29,25	SW	WSW
Sunday	9	42	50	29,54	29,73	W	SSW
Monday	10	40	53	29,80	29,84	WbS	SW
Tuesday	11	41	51	29,60	29,57	EbS	SW
Wednesday	12	40	53	29,62	29,50	SE	SE
Thursday	13	38	50	29,60	29,66	W	SW
Friday	14	37	54	29,47	29,35	SE	SE
Saturday	15	47	54	29,20	29,40	E	WSW
Sunday	16	41	52	29,72	29,81	W	SW
Monday	17	39	50	30,02	30,17	WbS	WbS
Tuesday	18	52	57	30,05	30,10	SW	W
Wednesday	19	36	47	30,29	30,32	W	W
Thursday	20	33	45	30,35	30,26	W	WbS
Friday	21	40	50	29,80	29,76	WbS	W
Saturday	22	34	46	30,04	30,03	NbW	W
Sunday	23	36	45	30,00	29,88	W	SW
Monday	24	40	48	29,72	29,70	SW	W
Tuesday	25	32	43	29,67	29,88	W	W
Wednesday	26	34	48	29,90	29,94	W	W
Thursday	27	45	48	29,94	29,94	W	W
Friday	28	34	46	29,99	29,91	SE	WbS
Saturday	29	37	52	29,81	29,80	WbS	WbS
Sunday	30	48	54	29,81	28,79	WbS	SW

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